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ELECTROKYMOGRAPHICAL STUDIES OF COARCTATION OF THE AORTA[1]

by

Sven Roland Kjellberg and *Ulf Rudhe*

Coarctation of the aorta consists of a constriction or atresia caused by a disturbance in development. The constriction is usually situated distal to the left subclavian artery, at or near the origin of the ductus arteriosus. It is occasionally found in the aortic arch between the innominate artery and the left common carotid. Multiple constrictions may also occur in the aortic arch or the descending aorta, at times associated with aneurysms.

A somewhat arbitrary classification has been made into an infantile and an adult type. The infantile type, frequently combined with a cardiac anomaly, is in the form of a diffuse narrowing of the aortic isthmus. The ductus arteriosus is seldom obliterated.

Constrictions of the adult type are more circumscribed and are usually situated near the origin of the ductus arteriosus. The ductus is patent in scarcely 10 per cent of the cases.

Clinically, the following main features are typical. There is a raised blood pressure proximal to the coarctation and a lowered pressure distal to it. The pulsations in the femoral arteries are weakened and retarded and there is a prominent system of collateral arteries. The forementioned changes in the blood pressure are not, however, invariably present. A number of cases have been reported in which no measurable difference could be noted between the blood pressure in the upper and lower extremities. It is true that hypertension is present in the majority of cases but instances of coarctation of the aorta with normal blood pressure have also been described.

As early as 1870, SCHEELE registered the changes in the pulse waves in a patient with coarctation of the aorta. Such changes have later been

[1] Submitted for publication June 7, 1950.

From the Roentgen Diagnostic Department (Head: Professor ÅKE ÅKERLUND) of Karolinska Sjukhuset, Stockholm, Sweden.

very thoroughly studied by, amongst others, BLUMGART et al. and LEWIS, and particularly by PORJÉ. When the blood passes the constriction, the pulse wave undergoes a change, the higher frequencies being eliminated to a varying extent. This results in a sinus-shaped curve (*v.* fig. 3 A). The pulse wave is also retarded and the notch occurring on the closure of the semilunar valves is entirely or partly obliterated.

Another feature of the disease, visible on the roentgenogram, is the notching of the ribs caused by the pressure of the dilated and tortuous intercostal arteries. These notches are not, however, pathognomonic but may occur in other pathological conditions (LAUBRY & HEIM DE BALSAC, BATCHELDER & WILLIAMS, HOLT & WRIGHT). Irregularities in the costal sulcus resembling these notches may appear in normal subjects (LAUBRY & HEIM DE BALSAC). Moreover, according to the most recent data, notching of the ribs occurs only in approximately 60 per cent of cases of coarctation of the aorta. The notches are seldom found in young children and their incidence increases with age. A dilated left subclavian artery, a shortening or dislocation of the aortic arch and absence of the aortic knob are not invariable findings.

Various forms of angiocardiography and direct thoracal aortography are indispensable for as exact as possible a diagnosis of the changes in this disease. This applies to the localization, degree and length of the coarctation as well as the presence of other cardiac and vascular lesions.

During recent years, electrokymography has become increasingly used as an additional diagnostic method. As regards accuracy, it cannot compete with the contrast injection method but it nevertheless provides valuable information. This also applies to cases with a not altogether typical clinical picture and a far from characteristic roentgenogram. This statement is borne out by one of our cases (Case 4) described in the following. In addition, the method can be used to illustrate the results of surgical treatment (see Case 5).

The electrokymographic recordings were made as follows. The photocell was first placed over the ascending aorta and the aortic arch. It was then moved down along the descending aorta as far as this could be followed, as a rule halfway to the arch of the diaphragm. It was thereby possible to ascertain the position of the coarctation.

Fig. 1 shows a typical electrokymogram (Ekyg) of a normal subject. Curve A derives from slightly above the semilunar valves and curve B from the descending aorta approximately halfway between the aortic arch and the diaphragm. These curves are characterized by a rapid rise coincident with the opening of the semilunar valves and a distinct notch followed by a further rise when the valves close. They may be described as composed of sinus curves with a fundamental wave of fairly low frequency and partials of higher frequency and lower amplitude.

Fig. 1 A.

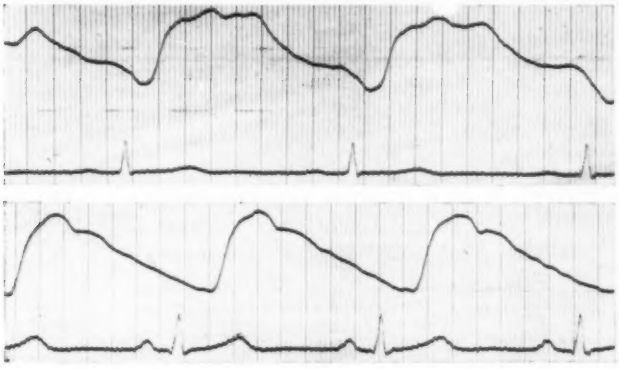
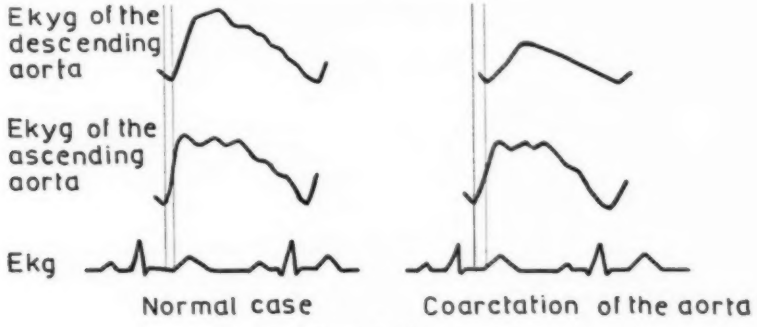


Fig. 1 B.

Fig. 1. A. Normal Ekyg of the ascending aorta
B. Normal Ekyg of the descending aorta

In coarctation of the aorta, the appearance of the Ekyg curve *distal to the stenosis* deviates from the normal, presumably varying somewhat with the degree and nature of the stenosis. Judging by the cases examined, the curve starts to rise later and the rise occurs more slowly than in normal cases, owing to the retardation of the pulse wave. As in the registration of the pulse, the higher frequencies disappear altogether or partly. This gives a more purely sinus-shaped appearance to the curve. In addition, the notch and the subsequent rise in the curve are obliterated to a varying extent (see schematic figure).



Schematic figure.

The apparatus and technique used in the present investigation are the same as those described in an earlier paper in Acta Radiologica (Engström, Kjellberg, Persson, Rudhe 1949). With one exception,

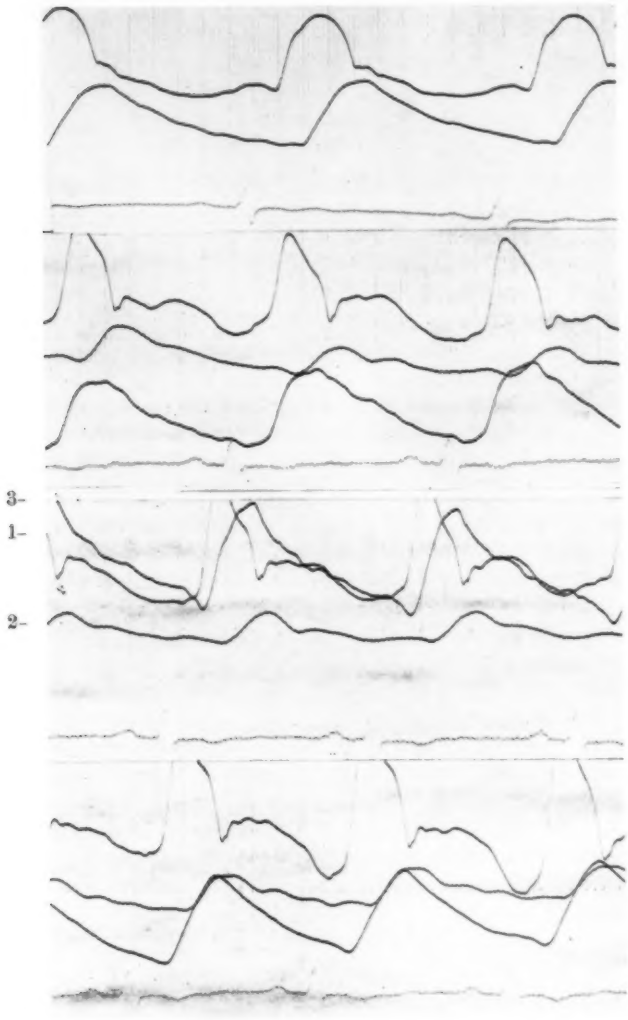


Fig. 2. A. Pulse curves: Upper curve: right internal carotid artery
Lower curve: right femoral artery
B. Upper curve: Pulse curve of the right internal carotid artery
Middle curve: Pulse curve of the right femoral artery
Lower curve: Ekyg of the ascending aorta
C. Curve 1. Pulse curve of the right internal carotid artery
2. Pulse curve of the right femoral artery
3. Ekyg of the aortic arch slightly above the coarctation
D. Upper curve: Pulse curve of the right internal carotid artery
Middle curve: Pulse curve of the right femoral artery
Lower curve: Ekyg of the descending aorta slightly below the coarctation

the pulse wave in the carotid and femoral arteries was registered simultaneously with piezoelectric receptors.

The case material studied consists of 12 patients with coarctation of the aorta, two women and ten men. Eleven of them belong to the adult type with the coarctation on a level with the origin of the ductus arteriosus. One case (Case 4) has been interpreted as atypical, the coarctation being proximal to the left subclavian artery. One additional patient (Case 5), operated on three months earlier for coarctation of the aorta of the adult type, has been included.

In order to illustrate the statements made in the foregoing, an account is given of five of the cases.

Case 1. S. G., aged 37. Director. Coarctation was discovered on mass miniature radiography. He was unaware of his illness and had suffered no discomforts.

A systolic murmur was heard in the first and second intercostal spaces and over the apex. There were distinct supraclavicular and infraclavicular collateral pulsations bilaterally.

Blood pressure: right and left arm 150/95
right and left leg 110/80

Roentgenological examination: Heart volume in the prone position 970 cc. Slight hypertrophy of the left ventricle. An indentation of the aorta was visible approximately at the level of the origin of the ductus arteriosus. Slight dilatation of the subclavian artery on the left side. Typical bilateral notching of the ribs.

Electrokymogram: Fig. 2. Curves taken slightly above and below the coarctation showed that the stenosis caused a retardation of the pulse wave, a slowing in the rise of the curve and an elimination of the secondary waves and a further rise caused by the reflux.

Case 2. G. L., aged 23. Student. The school doctor noted a murmur but considered that it would disappear in due course. The patient was very good at gymnastics. After strenuous exercise he had throbbing in the head and became red in the face.

Distinct collateral pulsations were visible bilaterally below the apex of the scapula. A harsh systolic murmur could be heard over the heart, most distinctly in the first right intercostal space beside the sternum.

Blood pressure: right and left arm 260/95
right and left leg 120/80

Roentgenological examination: Heart volume in the prone position 860 cc. Slight hypertrophy of the left ventricle. A moderate indentation of the aorta was visible at the level of the origin of the ductus arteriosus. Very slight dilatation of the subclavian artery on the left side. Slight notching of the ribs.

Electrokymogram: Fig. 3. There was a pathological change in the curve recorded slightly below the coarctation. The curve rose slowly, the rise caused by the reflux was indistinct and the secondary waves almost entirely obliterated. The pulse wave was retarded by 0.01—0.02 second.

Case 3. E. L., aged 49. Shop assistant. Coarctation was discovered on mass miniature radiography. He was unaware of his disease. He could partake in most activities and played some games but did not have very good staying powers.

Fig. 3 A.

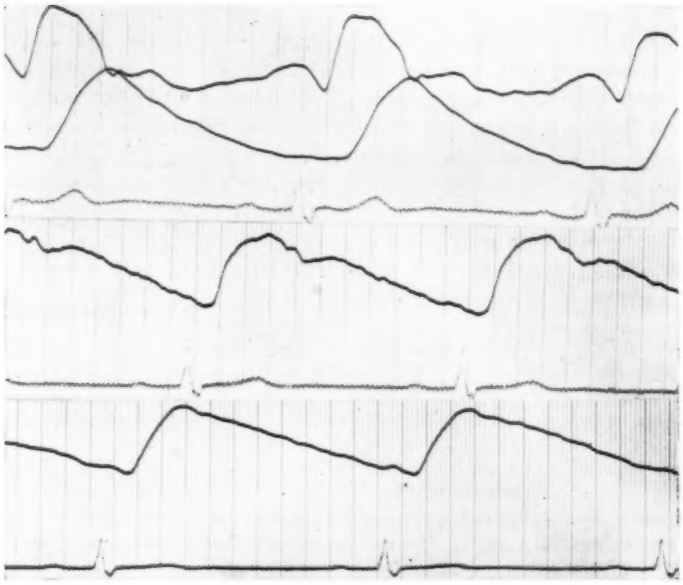


Fig. 3 B.

Fig. 3 C.

Fig. 3. A. Upper curve: Pulse curve of the right carotid artery
Lower curve: Pulse curve of the right femoral artery
B. Ekyg of the ascending aorta
C. Ekyg of the descending aorta slightly below the coarctation

A long-drawn systolic murmur was heard over the manubrium. Collateral anastomoses were palpable bilaterally below the clavicles.

Blood pressure: right arm 250/120
left arm 230/110

Roentgenological examination: Heart volume in the prone position 1,010 cc. Moderate hypertrophy of the left ventricle. Slight dilatation of the subclavian artery on the left side. A distinct indentation of the descending aorta was visible at the level of the origin of the ductus arteriosus. Slight bilateral notching of the ribs.

Electrokymogram: Fig. 4. The stenosis caused a distinct change in the curve. It rose more slowly and was more purely sinus shaped. Both the secondary waves and the rise caused by the reflux were entirely obliterated.

Case 4. B. S., aged 19. No cardiac discomforts. Routine medical examination revealed a cardiac disorder and the patient was sent to Karolinska Sjukhuset for further examination.

A long-drawn systolic murmur was heard over the whole heart, most distinctly in the first intercostal space, at which there was also a harsh diastolic murmur. The systolic murmur was also audible over the cervical vessels and the back.

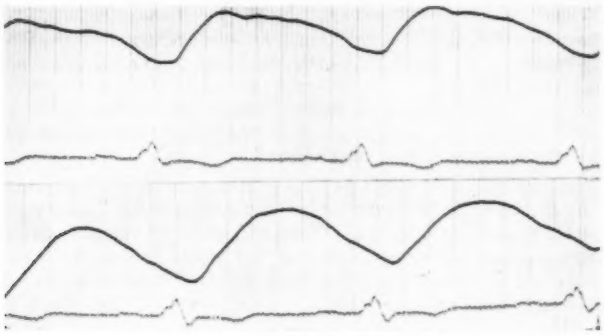


Fig. 4 A.

Fig. 4 B.

Fig. 4. A. Ekyg of the descending aorta slightly above the coarctation
B. Ekyg of the descending aorta slightly below the coarctation

Blood pressure: right arm 155/65
left arm and both legs 125/75

Total haemoglobin 940 g. Relative haemoglobin 105 per cent. Physical working capacity 1,300 kgm/min.

Roentgenological examination: Heart volume in the prone position 1,250 cc. Hypertrophy mainly of the left ventricle but presumably of the right as well. The shape of the heart did not appear to be abnormal. No dilatation or indentation of the aorta or notching of the ribs was visible.

The heart was considerably enlarged in proportion to both the volume of the blood and the physical working capacity.

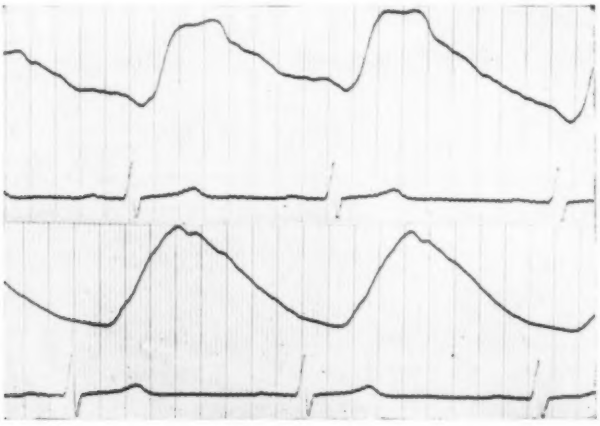


Fig. 5 A.

Fig. 5 B.

Fig. 5. A. Ekyg of the ascending aorta of normal appearance. The opening of the semilunar valves occurs, however, so early that valvular disease (bicuspid aortic valves?) can be suspected
B. Ekyg slightly distal to the left subclavian artery, distal to the coarctation

The appearance of the electrocardiogram was normal.

Electrokymogram: Fig. 5. The curves showed pulsations typical of coarctation of the aorta to be present in the descending aorta and the aortic arch as far up as the origin of the left subclavian artery.

In view of the electrokymographic findings and the difference in the blood pressure in the right and left arm, the coarctation was presumably situated in the aortic arch proximal to the origin of the subclavian artery.

Case 5. A. R., aged 32. The patient had been treated for hypertension since 1942 and operated on for this disorder in 1943. There was no improvement after the operation. She suffered from cardiac embarrassment and her working capacity was impaired. In 1949 she was operated on by Crafoord for coarctation of the aorta. On examination at Karolinska Sjukhuset three months later, the patient stated that she felt considerable improvement.

Before operation a strong systolic murmur and a whirring diastolic murmur were heard over the manubrium and in the second left intercostal space. The murmurs were also audible at the apex.

Blood pressure in both arms 230/110.

Roentgenological examination at Karolinska Sjukhuset three months after the operation: Heart volume in the prone position 790 cc. There was slight hypertrophy of the left ventricle. No deformity of the aorta was visible. There was no dilatation of the subclavian artery on the left side. Very slight notching of the ribs.

Fig. 6 A.

Fig. 6 B.

Fig. 6 C.

Fig. 6. A. Upper curve: Pulse curve of the right internal carotid artery
Lower curve: Pulse curve of the right femoral artery
B. Ekyg of the aortic arch slightly above the coarctation
C. Ekyg of the descending aorta slightly below the coarctation

Electrokymogram: Fig 6. Immediately below the site of operation the curve had the same appearance as in very slight stenosis. It rose only inappreciably slower than normally and there was very little obliteration of the secondary waves. The pulse curves also showed signs of slight constriction only.

The electrokymographic records of the other seven patients had essentially the same appearance as in Cases 1—3.

We are indebted to Dr CURT WESTMAN for his kindness in placing his patient material at our disposal.

SUMMARY

A description is given of the electrokymogram in coarctation of the aorta.

ZUSAMMENFASSUNG

Beschreibung des elektrokymographischen Bildes bei Coarctatio aortae.

RÉSUMÉ

Description de l'image électrokymographique de la coarctation de l'aorte.

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BILATERAL SPONTANEOUS PNEUMOTHORAX[1]

by

Nils Frostberg

Spontaneous pneumothorax in apparently healthy individuals is not an unusual occurrence. The onset is as a rule sudden with severe chest pain and dyspnea, for which medical advice is generally sought without delay. A spontaneous pneumothorax may, however, be symptomless or indolent, and be discovered by chance at routine roentgenography.

Spontaneous pneumothorax may be caused by a number of different factors. The commonest cause is probably tuberculosis, and formerly spontaneous pneumothorax was generally regarded as definite evidence of a tuberculous lesion of the lung. But pneumothorax is also known to occur in other diseases of the lung, such as pulmonary gangrene, pulmonary abscesses, pulmonary tumours, etc. Although the rupture of one or more emphysematous blebs is often the cause of a spontaneous pneumothorax, the condition is not common in patients with general chronic emphysema.

Spontaneous pneumothorax is, however, frequently seen in apparently healthy individuals in whom none of the above-mentioned causal factors can be held responsible. The cause of the condition in these cases is not obvious and still defies research. HAYASHI (1915) and FISCHER (1922) describe a fatal case of bilateral spontaneous pneumothorax in a 19-year-old otherwise apparently healthy youth. At autopsy scars with interspersed, thin-walled emphysematous vesicles varying in size from that of a pea to that of a cherry were seen in both apices. Microscopical examination showed only non-specific scar tissue; but in spite of this FISCHER thinks that healed tuberculosis was probably responsible for these »Spitzennarbenblasen». SCHMINCKE (1928) reports a case of bilateral spontaneous pneumothorax in a 28-year-old patient in whom

[1] Submitted for publication, June 28, 1950.

no evidence of tuberculosis could be demonstrated (repeated laboratory examinations gave negative results). The patient died after 9 months' stay in hospital. Autopsy revealed the surface of the lung to be studded with air-filled, hemp-seed-sized bullae, several of which had ruptured. However, in and beneath the pleura, a 1 to 2 mm. thick zone of embryonal tissue was observed. This tissue contained slit-shaped and irregular bullae lined internally with low cuboidal epithelium. Towards the parenchyma the blebs were in communication with alveoli, and some of them had ruptured into the pleural cavity. As the blebs often lay immediately lateral to the surface bronchioles, it was thought that they were valvular. Owing to lack of elastic tissue they had easily burst.

KJAERGAARD (1932 and 1933) gives a detailed description of the disease on the basis of a large collection. He suggests the name *pneumothorax simplex* for spontaneous pneumothorax in otherwise healthy individuals. He divides the cases into 3 groups:

1. Cases with scar bullae of the type described by FISCHER.
2. Cases with solitary emphysematous bullae that have ruptured by valve mechanism.
3. Cases in patients in whom congenital valvular bullae have been found in the pleural lining.

He is of the opinion that the last-mentioned cause is responsible for most cases of pneumothorax simplex and that familial occurrence suggests a congenital origin. BERLIN has recently described two families in which spontaneous pneumothorax was observed. In one of the families three members had developed this condition, and in the other also three, but probably four. These observations support KJAERGAARD's opinion.

The condition, which is more common among males, may occur in any age, but shows a predilection for the third to fifth decade of life, and is rarely seen in infants, except in newborns. In KJAERGAARD's comprehensive statistical survey one of the patients was only five years of age. FALKENFLETH describes a case in a six-year-old patient who was treated for about 6 months with repeated exsufflation.

That spontaneous pneumothorax is not a rare occurrence in newborns has been stressed by several writers and observed by RIEDWEG (1934), HOTZ (1934), SOLIS-COHEN & BRUCK (1934), BERTIN (1936), HOLZ (1936), WATERS (1936), ROTHMAN (1937), DE COSTA (1940), SINGLETON (1940), EMMERT (1940), CAFFEY (1945), and others. SOLIS-COHEN & BRUCK roentgenographed 500 newborns, one to five days old, in an investigation of enlargement of the thymus gland. They unexpectedly found pneumothorax in 11 instances, 4 being right and 7 left. No symptoms of the condition could be observed. DE COSTA stresses that pneumothorax in children is more common than generally assumed and that probably

not all cases observed have been reported. He traced 67 literature cases that had occurred during the first few months of life. Of these cases 46 and 2 of his own, thus altogether 48, were seen very soon after birth. HOLZ who described 3 cases, points out that the condition has been seen more than once in blood relations and that this therefore may suggest familial or constitutional weakness of the chest (see BERLIN above).

As a rule spontaneous pneumothorax is only unilateral; however, several cases are on record in which recurrent pneumothorax attacked first one side and then the other. Bilateral pneumothorax seems to be rare and only a few cases have been reported, viz. by SCHMINCKE (1928), HAYASHI (1915), FISCHER (1922), WATSON & ROBERTSON (1928), MASSINI & SCHÖNBERG (1916), ELTE (1928), FASCHINGBAUER (1919), BOWEN (1932), ROSSEL (1935), HASNEY & BAUM (1937), and BEGTRUP-HANSEN (1948). According to HASNEY & BAUM only 19 cases were on record up to 1937. But to this number must be added those observed in newborns by HOLZ (1936), WATERS (1936), HOTZ (1934), RIEDWEG (1934), BERTIN (1936), CAFFEY (1945) and others. KJAERGAARD seems to be of the opinion that the condition never occurs simultaneously in both sides.

The present writer had the opportunity to observe an eight-year-old girl with bilateral spontaneous pneumothorax, which, in view of the rarity of the condition, was thought to merit report.

Case Report

U. B. J. Girl, aged 8 years (Rtg. record Pm 215 and Pm i 120/49). According to the mother, the child had always enjoyed good health except for slight colds. She had not had whooping cough. There seemed to be no developmental anomalies, and she could tolerate considerable physical exertion. At the end of 1948 she had measles, which ran a favourable course. She had never complained of stitch or shortness of breath on exertion. At a mass radiography of the chest of all the inhabitants of Hässleholm (about 10,000) in November 1948 the roentgenogram of the girl in question showed: »medial in the right lung is an irregular shadow that should be verified roentgenographically.»[1] She was therefore referred to me for further examination.

Roentgen examination of the chest on 6th April 1949: »Bilateral spontaneous pneumothorax with moderate collapse of the lungs. The changes are more pronounced in the left side, where there is a small density also in the basal portion of the sinus. Good movement of the diaphragmatic cupola. No definite changes in the parenchyma are discernible. There is a thin adhesion from the top of the left lung. Heart: nothing remarkable.» (The change seen in the mass chest radiogram was probably due to a

[1] For purposes of comparison the roentgenogram was afterwards forwarded to our department. Already at the examination in 1948 the patient had bilateral spontaneous pneumothorax which had, however, escaped the attention of the examiner, probably because the film had been overexposed.

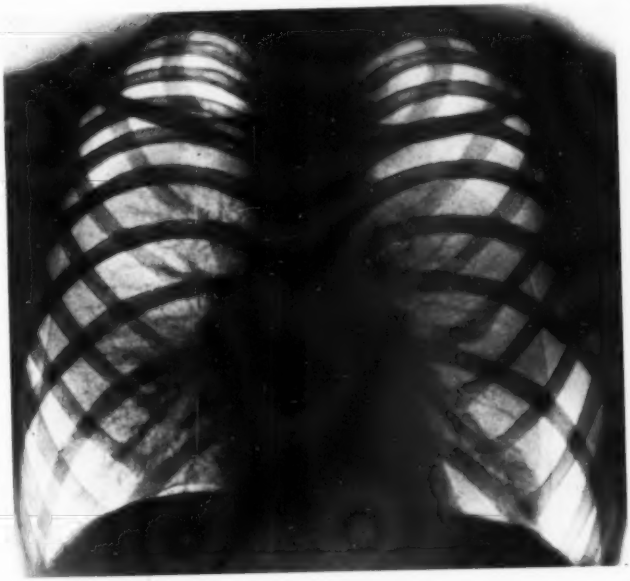

Fig. 1 a.

Fig. 1 b.

temporary atelectasis.) No emphysematous blebs could be detected. (Fig. 1 a & b.)

The pediatrician, who was immediately consulted, advised expectant treatment in the hope that the gas would be absorbed spontaneously and that the lungs would expand. The mother was requested to present her daughter for roentgen control at short intervals, and in the event of any deterioration in the child's condition, to communicate immediately with the writer. The child was allowed to continue school but not to take part in sports or gymnastics. Throughout the spring of 1949 the condition remained unchanged, as did also the picture presented by the control roentgenograms. Sometimes a small accumulation of fluid was observed in the basal portion of the sinus, and occasionally isolated small atelectases of varying localization were observed.

Towards the end of May 1949 the condition of the girl became worse. The mother reported that the girl felt sick and had vomited several times. The patient was roentgenographed without delay, and as the roentgenogram suggested an increase of the pneumothorax, she was immediately transferred to the previously consulted pediatric department, Central Hospital of Kristianstad,[1] where she was cared for from 25th May until the 15th June 1949, but as the pneumothorax increased in spite of rest in bed, she was referred to the Chest Clinic of the University of Lund.

Here thoracoscopy was performed on the left side. The strand-like adhesion extending from the apex to the thoracic cupola was extirpated. The microscopic structure of the extirpated adhesion was that of a fibrous connective tissue and contained no elements suggestive of congenital anomaly or the like. An irregularly shaped fistula, evidently opening into a bronchus, was observed in the posterior part of the apex 1 cm. below the attachment of the adhesion. The margin of the fistular orifice consisted of rather firm scar tissue and might very well have been a persistent pre-formed opening from fetal life. At any rate, it did not look like a recent lesion. Attempts were made to close the fistula by injecting a few millilitres of venous blood into the affected area of the upper lung. Moreover, the fistular opening and the surrounding emphysematous bullae seen in the surface of the lung were cauterized with a 20 per cent solution of lapis. The post-operative course was uneventful. The treatment was, however, of no avail. Repeated control-examinations showed that the pneumothorax persisted in both sides. It seems as if the fistula can be closed effectively only by a more extensive surgical intervention.

Inquiries into the family history, as well as clinical and roentgenological examinations, failed to show signs of spontaneous pneumothorax in any of the other members of the family.

Pneumothorax simplex generally has a good prognosis. The gas is as a rule absorbed spontaneously. Cases have, however, been reported in which the disease lasted 10 years (LE WALD). Resorption is rapid in newborns, too. DE COSTA who divides pneumothorax into two groups, »abrupta» and »lenta», points out that the mortality in the former group, which is the smaller, is high. In this group symptoms are serious and the pneumothorax practically complete. According to KJAERGAARD the greatest danger of pneumothorax is bleeding. He thinks the bleeding into the pleural cavity to come from small vessels in the valvular cysts or from burst adherences between the cyst and the thoracic wall. HANSEN

[1] I thank Docent Sten Axtrup and Docent Erik von Rosen for valuable information about the patient.

has observed cases in which as much as two to three litres of blood was lost. The small quantities of fluid occasionally observed in the bottom of the sinus in the writer's case might have been due to such small hemorrhages.

The greatest risk attending bilateral pneumothorax is thought to be suffocation. In the cases described by SCHMINCKE, FISCHER & HAYASHI, ROSSEL, WATSON & ROBERTSON, MASSINI & SCHÖNBERG the patients soon died from suffocation. The writer's case is thus remarkable also on account of its slight effect on the general condition of the patient and the hitherto favourable course it has run. The prognosis must, however, be regarded as dubious. In view of the risks known to attend the condition surgery seems to be indicated.

SUMMARY

The author describes a case of bilateral pneumothorax in an eight-year-old girl, whose general condition has hitherto not been affected. She has been under observation for one year. Cases from the literature are referred to.

ZUSAMMENFASSUNG

Verfasser beschreibt einen doppelseitigen Spontan-Pneumothorax bei einem 8-jährigen Mädchen, das keinerlei Zeichen einer Störung in seinem Allgemeinbefinden während der Beobachtungszeit von annähernd 1 Jahr erkennen liess.

Früher beschriebene ähnliche Fälle werden referiert.

RÉSUMÉ

L'auteur décrit un pneumothorax spontané bilateral chez une fillette de 8 ans, qui ne présentait aucune atteinte de son état général pendant la période de presque une annéé où elle fut observée. Relation de cas semblables, décrits antérieurement.

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FROM THE ROENTGEN DEPARTMENT (CHIEF: BORGE FABER, M. D.) OF THE COUNTY HOSPITAL, NÆSTVED, DENMARK

OSTEOCHONDRITIS DISSECANS OF THE HEAD OF THE ULNA[1]

by

Johannes Thoms

Osteochondritis dissecans most often affects the joint surface of the medial femoral condyle. According to BRICKEY and GROW more than 85 per cent. of the reported cases have involved the knee joint. Next in order of frequency is the capitulum humeri, which is homologous with the medial femoral condyle, whereas the lesion rarely involves other sites. A special syndrome involving the capitulum humeri has been described by PANNER who classified the disease in the same group as Calvé Perthes' disease. KRAGELUND has found reports of involvement of the hip joint, shoulder joint, the acromio-clavicular joint, the first and third metacarpo-phalangeal joints, the tibio-fibular joint, the talo-crural joint, and one affecting the mandibular joint. Osteochondritis dissecans of the ankle and metatarso-phalangeal joint has been reported by BRICKEY and GROW and by AAGE NIELSEN, of the talus by K. B. RASMUSSEN, of the patella by COX, of the talus, patella and trochlea humeri by LAVNER, and of the lateral malleolus by HERMODSSON.

Osteochondritis dissecans of the head of the ulna does not appear to have been reported earlier.

Case Report

Out-patient, Case rec. 967/50, girl, aged 13, E. J. P. Her father had died from Hodgkin's disease, but otherwise the family history was negative. Mother in good health. The patient was an only child.

Delivery normal, birth weight 4.5 kg. History of pneumonia at the age of 18 months, not hospitalized. At 8, she was admitted to the Medical Department in Næstved (Case rec. 156/44). According to the case record, the patient had been in a good nutritional state ever since birth. She had been eating much with a ravenous appetite and had always

[1] Submitted for publication, May 29, 1950.

been an alert and robust girl. Admitted for observation because of obesity. Objective examination: Height 124½ cm., weight 35 kg., B. M. R. —3 %, serum cholesterol 102 mg. %. Other findings normal. Roentgen examination of the skull, shoulders, elbows, and pelvis showed normal conditions. The diagnosis was adiposity, and the patient received no treatment.

Three years before the present examination, the patient had a fall, and a diagnosis of fracture of the left radius was made in this department (Roentgenogram No. 2113/46). Fig. 1 shows the greenstick fracture through the distal part of the body of the radius. No bony abnormality in the ulna or the distal epiphysis. Treatment: Plaster of Paris (dorsal cast).

Ever since, there have been occasional slight pains and unrest in the joint, when overstrained by lifting heavy objects. The symptoms always subsided spontaneously and were not severe enough to take the patient to a doctor. On the day prior to the present examination the patient fell off her bicycle. She was unable to explain how she had fallen, but shortly after, the left wrist became swollen, and there had been constant pain accentuated by dorsal flexion.

Obj. exam.: Slight swelling of the dorsal aspect of the left wrist. Dorsal flexion somewhat restricted and elicits increased pain. The patient is rather adipose. Height 152 cm., weight 58.4 kg. Other findings normal.

Roentgen film of the left wrist (967/50), Fig. II: Immediately radial to the root of the styloid process of the ulna there is a semicircular defect in the joint surface of the head. The defect has quite smooth borders, and in its centre there is a loose, slightly irregular sequestrum, the size of a wheat grain. No bony changes in the radius.

Roentgenograms of the right wrist, both elbow joints, shoulder joints, knee joints, ankles, and pelvis showed normal conditions. The osseous development is normal, and there are no signs of osteochondritis dissecans or aseptic necrosis of bone.

Roentgen diagnosis: Osteochondritis dissecans of the head of the left ulna. Loose body in left wrist.

The etiology of osteochondritis dissecans has not yet been fully elucidated. In the course of time it has given rise to much discussion, particularly concerning the etiological significance of injury.

In the particular cases reported by PANNER, the onset of the disease coincided with direct injury, whereas in a similar case reported by KREBS (Panner's disease) an injury was found to be unrelated to the onset.

In his comprehensive paper on osteochondritis dissecans of the capitulum humeri, AAGE NIELSEN gave a thorough historical review of the etiology and pathogenesis. On the basis of his own series, he substantiated the common familial occurrence of osteochondritis dissecans, showing that there is almost certainly an hereditary element in the etiology. He claimed that the past histories excluded injury as an etiological factor in previously healthy joints. This view is seconded by H. STØREN who made a sharp distinction between osteochondritis dissecans and the posttraumatic cases.

On the other hand, AXHAUSEN, basing his conclusions on a series of clinical and experimental studies, stated that injury must be the factor eliciting the nutritive disturbance which leads to the involved part being walled off and eventually becoming a true sequestrum.

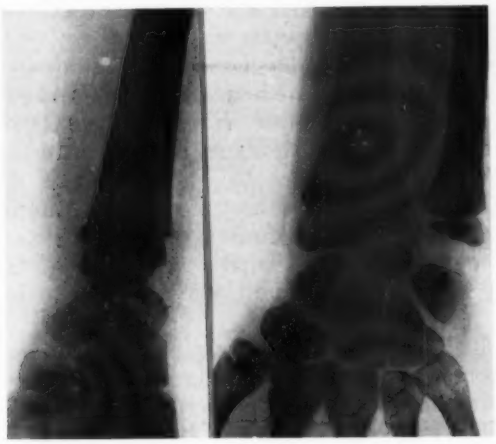

Fig. 1. Roentgenogram showing the patient's wrist in 1946 (No. 2113/46). Diagnosis: Fracture of left radius.

Fig. 2. Roentgenogram showing the patient's wrist in 1950, 3 years after Fig. 1 (No. 967/50). Diagnosis: Osteochondritis dissecans of head of left ulna. Loose body in left wrist.

The pathological features of the affected joint surface have been studied in detail by S. NAGURO who succeeded in reproducing the lesion experimentally by exposing rabbits to injuries.

To-day it is commonly believed that among several etiological factors, one or repeated injuries predominate.

Among recent reports on osteochondritis dissecans probably caused by injury, the following are worth mentioning: KILFOY's one case involving the head of the left radius, BRICKEY and GROW's three cases, BENNETT's description of the shoulder and elbow lesions in baseball pitchers with particular reference to osteochondritis dissecans, K. B. RASMUSSEN's, COX's, and HERMODSSON's cases. Among his 33 cases, LAVNER interprets 22 as being definitely traumatic.

The present case of osteochondritis dissecans of the head of the ulna appears to fulfil all the conditions required to be recognized as traumatic.

The patient had sustained an adequate injury so severe as to cause a greenstick fracture of the radius, whereas the ulna and particularly the head, failed to show any signs of fracture. Since this first injury, the patient had noticed symptoms from the wrist when overstrained. A new injury, 3 years later, gave rise to severe symptoms in the wrist in the form of swelling, tenderness, and pain upon motion. On the subsequent day a fully developed osteochondritis dissecans with sequestration was diagnosed. The osseous development had been found to be normal at previous examinations, and osteochondritis dissecans was not demonstrable in joints other than the injured one.

SUMMARY

After having enumerated the various sites which may be involved by osteochondritis dissecans, the writer reports a case affecting the head of the ulna, a localization which does not appear to have been reported earlier. Reviewing the current discussion about the etiology of the lesion, the writer claims that the lesion was caused by an injury sustained 3 years previously.

ZUSAMMENFASSUNG

Nach Aufzählung der verschiedenen Lokalisationen, die eine Osteochondritis dissecans haben kann, berichtet Verf. über einen das Ulnaköpfchen angreifenden Fall, eine bisher anscheinend noch nicht beschriebene Lokalisation. Er beschreibt die herrschende Diskussion inbezug auf die Ätiologie des Leidens und macht geltend, dass die Krankheit in seinem Falle durch eine 3 Jahre früher stattgehabte Verletzung bedingt war.

RÉSUMÉ

L'auteur énumère d'abord les diverses régions qui peuvent être atteintes d'Ostéochondrite disséquante, puis il relate un cas où l'affection portait sur la tête du cubitus, ce qui est une localisation qui ne semble pas avoir été signalée jusqu'ici. Passant en revue les hypothèses courantes sur l'étiologie de la lésion il défend l'idée que dans son cas elle fut causée par un traumatisme vieux de trois ans.

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FROM THE ROENTGEN DIAGNOSTIC DEPARTMENT (HEAD: PROFESSOR ÅKE ÅKERLUND)
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FILM-FAULTS CAUSED BY CONTACT BETWEEN ROENTGEN FILMS DURING THE DEVELOPMENT[1]

by

Ove Mattsson

Film artefacts observed in the Roentgendiagnostic Department proved on many occasions to disturb the proper evaluation of films under study. These faults are caused by improper processing and are easy to avoid although their appearance seems quite mysterious at first. Fig. 1 represents a detail of a chest-radiograph. In the neighbourhood of the right hilum some figures are easy to discover. They correspond exactly to the date-marks we see on each picture, but form a negative image of them. This phenomenon has a certain resemblance to the film-fault described in 1924 by ÅKERLUND, but is due to a different cause. A close examination shows not only the figures but also to the right the contours of a picture-margin. It has in relation to the figures a special position.

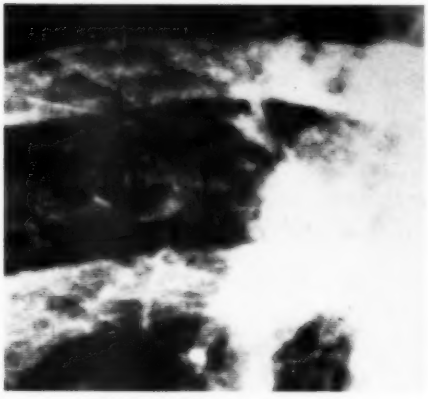


Fig. 1.

All the films developed at the same time were examined. Among these one film was discovered, on which the date-marks had exactly the same typical position in relation to the picture-margin as demonstrated in fig. 1. Both films could be arranged in such a manner that a complete

[1] Briefly presented at the 16th Meeting of the Northern Association for Medical Radiology, Stockholm, June 10—12, 1949; submitted for publication, April 20, 1950.

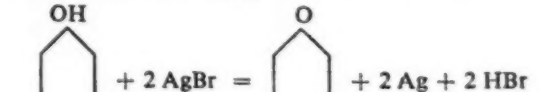
Fig. 2. The date-mark and the negative image of it on the other film below. The emulsion is partially removed from small areas of the both surfaces of that film, demonstrating that the negative figures are located only in one emulsion layer. A. The emulsion layer has been removed from the contact surface. B. The layer has been removed from the opposite surface. C. Both emulsion layers have been removed.

congruence between the positive and negative figures resulted. It was also discovered that if they were arranged so, the upper margins of both the films were on the same level in exactly the same position as in the developing bath. One could then assume that the artefact had been caused by contact of the film surfaces during the developing process. This assumption was proved experimentally. It was easy to reproduce this phenomenon whenever the surfaces of two films were in contact with each other toward the end of the developing time.

The pictures (fig. 2) show some of the experimental films. One film was exposed to Roentgen using average factors. Its homogeneous blackening corresponds to that of an average film. On another film the usual date-mark was produced with an apparatus constructed by ÅKERLUND and regularly used in our department. After a minute in the developing bath the two films were brought in contact with each other and that contact continued unaltered during the remaining period of the developing time (about 5 minutes). The pictures show that a negative of the date-mark could be produced on the other film. By removing the emulsion from a small area of both surfaces of that film it was possible to prove that the negative figures were located only in that emulsion layer which has been in contact with the surface on which the date-marks were stamped.

The chemical process which goes on in a developing bath may explain these phenomena. During the developing process reaction products are generated. Through diffusion and circulation within the bath they are removed from the emulsion surface and are diluted. At the same time fresh portions of solution are continuously brought to the film surface. The quantity of the reaction products generated is proportional to the amount of reduced silver.

In the developing solution the active agent reduces silver. The usual agent which is used either singly or in combination with other similar reducing substances is hydroquinone. An alkali, such as sodium or potassium hydroxide, is always added as an accelerator. The preservative, sodium sulfite, is necessary to minimize the effect of oxidation from air. The figures below illustrate simply the chemical course.



$$HBr + NaOH = NaBr + H_2O \quad \ldots\ldots\ldots\ldots$$

hydrogen bromide *sodium hydroxide* *sodium bromide* *water*

Fig. 3.

Hydroquinone reduces the exposed silver in the emulsion to free silver. Quinone and hydrogen bromide are also formed. Of these products hydrogen bromide reacts with present alkali ions forming bromide of potassium and sodium. Quinone reacts in several ways. With alkali it forms hydroquinone, with sulfite hydroquinone monosulfonate, and with oxygen from the air in the presence of sulfite several other products, which all have developing ability. The substances, which are of the greatest importance in connection with the appearance of these film-faults, are the bromides which are produced.

The influence of the bromide ions on the developing process is well known. The development is strongly retarded and the diagram gives an example of the influence of the concentration of bromides (fig. 4). The diagram shows a sensitometric curve with the usual arrangement of density and logarithmical values of exposure. Under otherwise identical conditions the density curve shows a lower density in the presence of bromide ions, *i. e.* it runs deeper.

The mechanism causing film faults mentioned above seems to be the following.

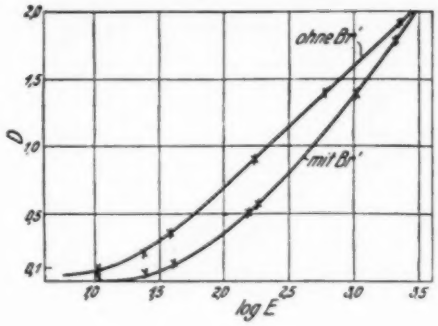


Fig. 4. Influence of the concentration of bromide ions on a sensitometric curve.
0.05 m Hydroquinone,
0.05 n NaOH.
(0.01 n KBr).
Time of development: 6 minutes.
(From HAY: Handbuch . . . Bd 5.)

The surfaces of two films were brought in contact with each other after the developing process had started. These surfaces were isolated from the surrounding fluid. On points with high density many reaction products will be generated and among them bromides. The bromide ions will have a local influence upon the development of the emulsion layer in the immediate neighbourhood causing a retarded process and a lower density. The retardation is most pronounced where the quantity of reduced silver is highest, *i. e.* on the most exposed details of the film-mark. On the neighbouring surface of the other film there will be a sort of negative picture of the highly exposed details which is produced in a chemical way.

Some well known artefacts in scientific photography can be explained in a similar way as the above mentioned film fault, since they are caused by the retarding influence of the reaction products upon the developing process. They are phenomena which appear under absolutely normal developing conditions. A well known phenomenon is the Eberhard effect, often called »neighbourhood effect». The density of a field that is exposed everywhere with the same intensity is not homogeneous. The density depends from point to point on the close relationship to other dense parts, which always reduces the density in question. Fig. 5 shows an example of this fact. It shows a series of exposures made for sensitometric purpose, each greater than the preceding step. All the small fields are homogeneously exposed, but the density in them varies and is evidently increased in the neighbourhood of a field with less exposure and decreased

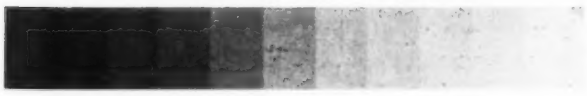


Fig. 5.

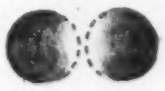


Fig. 6.

Fig. 7. (From EGGERT: Einführung in die Röntgen-Photographie.)

in the neighbourhood of a field with more exposure. This phenomenon is of great importance in sensitometry.

In an area with sharp limits against less exposed parts the same phenomenon appears as a »border effect» — the central parts having less density but showing an increase toward their borders. On very small spots the same phenomenon appears as an »area effect», when a very small field gets a higher density than greater ones with the same exposure.

An interesting effect appears when two very small spots are situated very close to each other. The density will then be less pronounced in

Fig. 8.

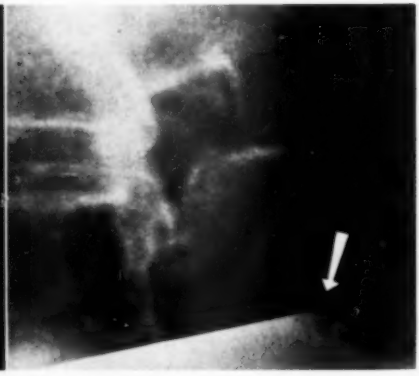


Fig. 9.

Fig. 10.

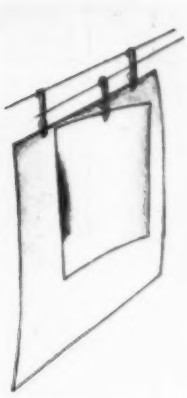


Fig. 11 a.

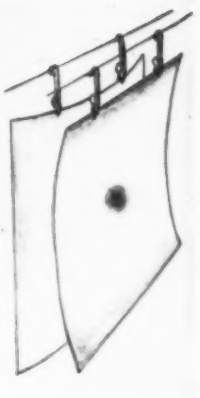


Fig. 11 b.

points of the two fields which are nearest to each other and the distance between the two points will then obviously be too great. On the drawing (fig. 6) the limits of the homogeneously exposed fields are marked with points. This phenomenon is called the Kotcinsky effect, and it is of very great importance in astronomical photography and spectrography in measuring photographic plates of stars which are situated very close to each other and in the measuring of spectral lines.

All these phenomena have been explained by MEIDINGER, who refers to the increased concentration of reaction products with retarding effect on the development. That effect is thus evident under normal conditions. Another phenomenon appears when a film is allowed to develop in vertical position in a developing bath in which there is no movement present. The reaction products from a strongly exposed area, especially the bromides, which are comparatively heavy, sink by force of gravitation and retard the developing process below. Fig. 7 illustrates that fact.

In all the well known photographical phenomena described the influence of the reaction products on the density of one and the same photographical layer was discussed. In the above mentioned film fault, however, it has instead been the influence on the emulsion layer of *another* film that was in the immediate neighbourhood.

Two other examples of this rare film fault are given in figs. 8 and 9.

In connection with faults of this kind some other more common film faults which are caused by a contact between two Roentgen films during the development should be mentioned. A film fault that is very easy to recognize and explain appears when the edge of a film was in contact

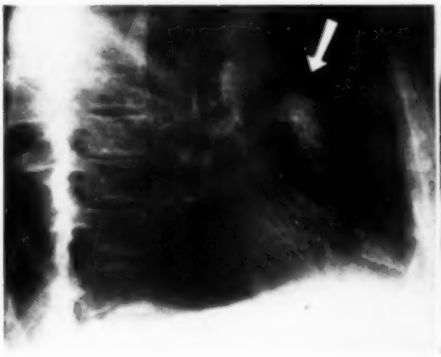


Fig. 12.

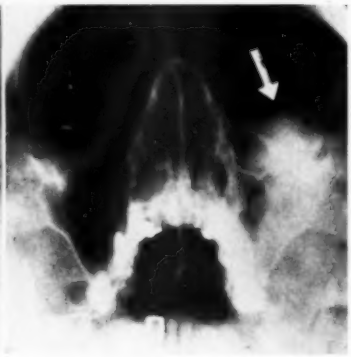


Fig. 13.

Fig. 14.

with the surface of another film during the development. The contact area is not subject to the developing process and shows reduced density. This area is limited by a sharp straight line corresponding to the edge of the other film and the other borders are unsharp showing a slow transition into the normal density of the film, which is caused by the successively increased distance between the surfaces. Fig. 10 shows such a fault. The drawing (fig. 11 a) illustrates in a simple way the explanation of such a fault.

If films in the developing bath are bent and if the axes of the corresponding curvatures form an angle with each other the contact between two films during the development can give an area of reduced density that has unsharp limits in all directions (fig. 11 b). Such an area of reduced density can have exactly the same appearance as pathological findings

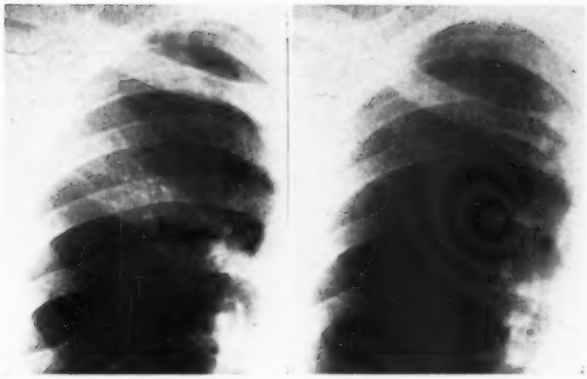


Fig. 15 a. Fig. 15 b.

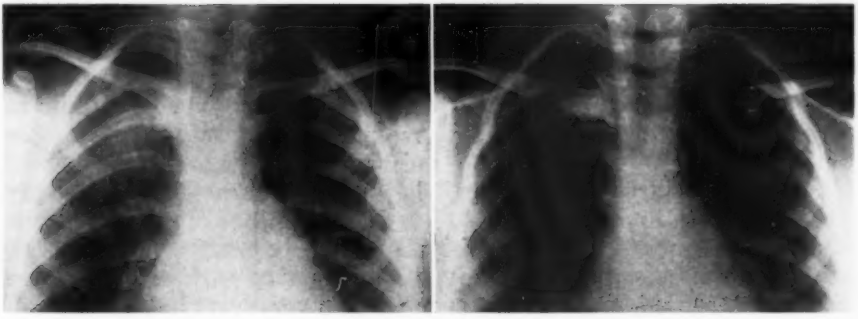


Fig. 16 a. Fig. 16 b.

on chest radiographs, for example. Fig. 12 shows a chest radiograph with such a fault. Another lateral view taken some minutes later showed quite normal conditions.

Figs. 13 and 14 show two other examples of such faults.

The two chest radiographs shown in fig. 15 a and b were taken some years ago with a one day interval. The area of reduced density in the upper part of the right lung in the first picture (a) has the appearance of a pathological finding. It was then considered to be a transitory athelectasis with full regress in the second picture (b). A later study of the films recently showed that it was caused by a film fault. Fig. 16 a and b are two chest radiographs of a 5 years old child, who was suspected for a disease of the chest; to the left an ordinary p. a. chest film and to the right a more penetrated view. Both of them show suspicious pathological findings in the upper part of the right lung, and as the findings have

Fig. 17.

about the same appearance on two pictures a pathological process might be probable. In fact both findings are film faults and as exactly corresponding points of the images have been in contact during the development it is very easy to overlook the possibility of an artefact. A further examination with a new set of radiographs showed quite normal conditions.

These types of film fault involve only one of the two emulsion layers of the Roentgen film. To verify the one-sided location of a suspicious finding it is necessary to examine very carefully both sides of the film studying the light reflexes. A layer-surface with reduced density reflects more light and seems to be more clear when looking at it in reflected light. This phenomenon is easily verified by means of sensitometrical steps. The properties of the emulsion layer can be easily studied under a microscope. A microscopical study shows that the surface of the areas with very high density and great quantity of silver is very irregular. Small hills, corresponding to superficial groups of silver grains, are seen. Areas with less density show, however, a smoother surface. The gelatine in the emulsion layer is evidently contractible and where no silver has been reduced the gelatine contracts after processing to a homogeneous mass with a regular smooth surface. It reflects the light much better than the irregular surfaces of areas with high density.

A reduced density localized to only one of the two layers is thus easy to discover by examination of both layers in front light and by study of reflexes (fig. 19).

Fig. 17 shows a detail of a chest radiograph with a film fault of the above mentioned type. Fig. 18 a and b are photographical pictures of the *light-reflexes* of both layer surfaces of that film, made with the camera in the position of the examining eye as in fig. 19. The brilliant light-reflecting area corresponds to the fault and is localized only to *one* of the layers (left picture). Such light reflecting areas have earlier often been considered to be caused by imperfect applying of the emulsion layer in manufacture.

Fig. 18 a.

Fig. 18 b.

Many manufacturers have applied a very thin transparent gelatin layer over the light-sensitive emulsion to protect it from abrasion. This overcoating, which usually has only a thickness of about 1 μ, does not disturb the proper examination of the light-reflexes.

Summing up these facts, one can say that a contact between two films in the developing solution as a rule gives areas of reduced density if the contact is of a sufficient duration. Of course, a contact between a film and the wall of the developer tank can also give uneven development and irregular density. Under special and rarely occurring conditions it is possible to get a negative reproduction of details from one film to the other.

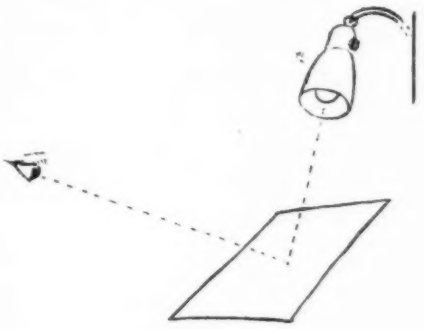


Fig. 19.

In order to prevent film faults of the above mentioned type it is necessary to avoid placing the films too close to each other. Large radiographs should be placed at a distance of at least 2 inches from each other and of course not too close to the walls of the vessel. The most important thing is a continuous control by laboratory attendants.

SUMMARY

The author describes and explains the genesis of some types of film faults caused by contact between Roentgen films during the development. Some of these faults often disturb the proper evaluation of the films and may simulate pathological findings on chest radiographs for example. The film faults involve only one of the two emulsion layers of the Roentgen film. To verify the one-sided location of a suspicious finding it is necessary to examine carefully both sides of the film studying the light reflexes. A layer surface with reduced density reflects more light and seems to be more clear when looking at it in reflected light.

ZUSAMMENFASSUNG

Verf. beschreibt einige verschiedene Typen von Filmfehlern, die durch Berührung der Röntgenfilme miteinander beim Entwickeln entstehen. Einige dieser Fehler erschweren oft die Beurteilung des Bildes und können, z. B. in Lungenaufnahmen, pathologische Befunde vortäuschen. Die Filmfehler sitzen bloss in der einen der beiden Schichten des Röntgenfilms. Sie lassen sich also durch eingehende Untersuchung der beiden Filmoberflächen in auffallendem Licht erkennen. Durch Studieren der lichtreflektierenden Fähigkeit der Oberflächen lässt sich die einseitige Lokalisation einer verdächtigen Veränderung feststellen.

RÉSUMÉ

L'auteur décrit quelques types différents de défauts apparaissant sur des films radiologiques lorsqu'ils ont été en contact entre eux pendant le développement. Certaines de ces défectuosités rendent souvent plus difficile la lecture de l'image, et peuvent simuler des trouvailles pathologiques, par ex. sur des négatifs de poumons. Les détériorations sont localisées à une seule des deux couches sensibles du film. On peut donc les mettre en évidence par un examen soigneux des deux surfaces en lumière tombante. Par l'examen de la qualité des reflets lumineux des surfaces il est possible de prouver l'unilatéralité d'une altération suspecte.

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SOME DETAILS IN THE EQUIPMENT OF THE NEW ROENTGEN DEPARTMENT OF THE BISPEBJERG HOSPITAL, COPENHAGEN, DENMARK[1]

by

Chr. I. Baastrup

Head of the Roentgen Department

Detailed descriptions of newly instituted roentgen departments generally are only of slight interest because any differences between the various clinics, as a rule, depend on local conditions as the form and size of the building concerned, the number of beds in the hospital, and the general number of out-patients as well as the character of the equipment and the plans of the installing firms. Occasionally, perhaps, an account of such details may offer some valuable suggestions as to the institution of a new roentgenological clinic, but most often they represent merely some completely indifferent variations of the same theme which anyhow will have to be carried out with other variations suitable for the given case.

It is a different matter, however, when it comes to details which really are new and perhaps mean a break with the arrangements usually employed. A good many newly opened roentgen clinics present some new ideas or details which every radiologist will be interested in getting acquainted with. All too often, however, such original ideas and arrangements are lost in the detailed account of indifferent and ordinary things.

In the following a brief outline will be given of the general and less interesting plans of the new roentgen department of the Bispebjerg Hospital. But this account is essential to the understanding of some new details and ideas that have been realized in this clinic, and which may not be looked upon as familiar to roentgenologists in general. Still, it has to be mentioned that some of these constructions are by no means new, having been employed in this hospital for years; and consequently they are well known to previous assistants and visiting colleagues, who

[1] Submitted for publication, July 28, 1950.

perhaps have even adopted them, so that they are no longer new to these radiologists. I have drawn the line so that the principles and constructions which, as far as I have been able to ascertain, have not been mentioned hitherto in the literature are dealt with here, whereas no description will be given of details that may be assumed to be familiar to most radiologists.

The new Roentgen Department of the Bispebjerg Hospital was opened in January 1943. Certain things are wanting yet, however, because we have been unable to provide them during and after the war.

In the complex of the hospital, this department is situated as centrally as possible. The hospital, which is not finished yet, comprises today 1,100 beds, but when completely finished, it will presumably comprise about 2,000 beds. At present the hospital is made up of surgical, medical and psychiatric departments, but other special departments are planned. Some ambulatory patients are treated, too, and a very large out-patient clinic for roentgen diagnosis is now being built.

For architectural reasons, the roentgen clinic is placed like the transversal in the capital letter H. Only one of the four wings is completed. It comprises a surgical department, of which the operating rooms occupy the ground-floor in the roentgen building. The direction of the latter is about North—South. It is 63 m long, 19 m wide, with a middle aisle of 4 m which receives its light from the ends and through glass doors in the side rooms.

The roentgen department, occupying 4 storeys (area per storey: 1,197 square meters, with a height of $3^3/_4$ m), accomodates the following services:

The basement is intended for universal light baths. Subsequently, if necessary, the area may readily be increased by 100 %.

The ground floor, as already mentioned, is now being occupied as operating rooms, anesthetizing rooms, etc., for one of the surgical departments.

The next storey is used for roentgen therapy. The storey above accommodates the roentgen diagnostic section of the clinic, and the top storey comprises studios and dark-rooms for ordinary photography, a large reading-room, a laboratory, dining-rooms, dressing-rooms, bath-rooms, etc.

In the planning of roentgen clinics, generally, the space for eventual extensions is not calculated sufficiently large. I have reckoned with the possibility that *the diagnostic section should be extensible by 50 % or 100 %*, if this might be desirable later on, as the therapeutic section may be moved entirely or in part to one of the wings which later are to join the roentgenological clinic.

At present the roentgen department has only one chief, but it may readily be divided between two chiefs: a diagnostic and a therapeutic. If subsequently it should prove expedient[1] to establish three roentgenological departments — two diagnostic and one therapeutic — this might also be done easily if the therapeutic department gets its quarters in one of the wings not built yet, so that each diagnostic department has a whole storey to itself.

The Roentgen Diagnostic Department

This section comprises 10 rooms for examination: *1 for gastrointestinal diagnoses on men, and 1 for women. 1 urographic room for men, and 1 for women.* Each of these rooms is equipped with two seesaw tables. *1 room for pyelography and hysterosalpingography for each of the three surgical departments of the hospital.* To have one room for men and another for women is a practical arrangement in a good many examinations. As to pyelography it is more practical to have one room for each of the surgical departments, as cystoscopy takes so long that in the roentgen department we cannot spare any of our staff for this purpose. Therefore, this work is left to the surgical department to carry out by themselves, and each of them has one room at its disposal for this purpose throughout the forenoon — of course with the assistance of the roentgenological department.

In addition, there is a large room for tomography, examination of the skull with employment of a Lysholm table and apparatus for dental examination, one small room for ordinary roentgen examination of bones, and *1 room equipped for examination of the gastrointestinal tract as well as for any other diagnostic tasks* — excepting examination of the skull. This examining room is used when the machinery in one of the other rooms is out of order, or on days when there happen to be particularly many patients, for instance, for gastrointestinal examination. This room is being used a great deal, and it has proved a very practical and time-saving arrangement — not least because the modern condensator apparatuses fail very often. With the exception of the rooms for pyelography and roentgenography of bones, *all the diagnostic rooms are equipped with apparatuses for roentgenography of the lungs and heart.* Thus, when the examination has to include the chest, besides the abdominal organs, we do not have to move such patients to another room. (In the Bispebjerg Hospital, as a matter of routine, roentgen examination of the heart is performed on all patients prior to an operation.)

[1] In my opinion, a roentgen diagnostic department should not serve more than 1,000 hospital beds.

There is a W. C. in direct connection with the gastrointestinal rooms and the all-round examining room, a wash basin in every room, and 2 dressing cabins per examining room — excepting the rooms for pyelography, in which experience has shown that they are not required.

In the room where fluoroscopy is performed the ceiling light is yellowish-green — as near as possible, of the same color as the screen. After trying out a number of different colors in the course of time, I realized that the color of the screen or its complementary color must be the one that would be least inconvenient to the adaptation. From theoretical considerations — that would take too long to enter into here — I found that yellowish-green would be the most proper, and practical experiments proved this to be correct. The yellowish-green light may be turned on so intensely that one is enabled to read the case records, without getting after-images or injuring the adaptation.

Among the accessories for roentgenography, mention may be made of *lead-lined half-boxes*, covering one half of the surface of the cassettes. They are employed whenever one wishes to divide a film for 2 exposures. They can be made by any cabinet maker. They divide the film exactly in the middle, allowing the film to be utilized as completely as possible and preventing skew or dentate dividing lines as are seen frequently on employment of loose pieces of lead.

As mentioned before, the roentgenological department is situated in a rectangular building. Naturally, it is very important that the way is not too long from the examining rooms to the dark-rooms, and hence there are 3 dark-rooms in our clinic: two of them being situated between two examining rooms, the third between 4 and 2 examining rooms, respectively. From the most distant examining room the cassettes are transported to the third darkroom through a lead-lined tunnel by a motor-driven paternoster band.

The sluices in the walls between the examining rooms and dark-rooms are divided into two rooms: 1) one for cassettes with unexposed films (this space also serves as a cassette cabinet) and 2) the other for cassettes with exposed films. In the latter the bottom is movable, with an electric switch underneath. *When the bottom is forced down by a cassette, a red lamp is switched on in the dark-room. At the same time red lamps are switched on in the two other dark-rooms, so that the photographers in all 3 dark-rooms continuously can watch that all the films are taken care of.* Similarly, red lamps are switched on in all 3 dark-rooms when a cassette reaches the dark-rooms through the above-mentioned tunnel.

The dark-rooms are divided into a »dark» part and a »light» part, the former being used for development and the first fixation. The fixing tank goes through the wall, from the dark part into the light one — of course, in such a way that the lid of the tank cannot be opened on both

sides at the same time. The tanks are surrounded by running water, which automatically is kept at a constant temperature. In the dark compartment the walls are light — which is useful to the photographers, as the frames of the films hang on the walls. The slight reflection from the light walls does in no way injure the films.

The light compartment of the dark-rooms is equipped with tanks for after-fixation and washing, a zink for bleaching, drying boxes and indirectly illuminated plans for examination of wet films, etc. *The films from each examining room are developed each on its own side of the dark-room, fixed, washed, and dried — likewise separated from films from the other side.* This makes it easier to find a given film than if the films were mixed together in the same developing tank. Naturally, there are two drying boxes for each dark-room. Each drying box is equipped with an electric bulb, making it easy to find the film one wants. The entire height of the room is fully utilized in the drying boxes, as vertical paternoster bands, carrying the sticks on which the films are hung up, lift them and gradually, as the box is being filled, carry them to the back wall of the box. As long as the films are dripping they will be hanging over even wetter films. When they drip no longer, they hang in the background; but, if they are to be used, they are easy to get hold of.

Reading Rooms

Two large and some smaller rooms are equipped for the reading of the roentgenograms. The large rooms have an illuminating table on the middle of the floor, with light to both sides. These tables are 6 m long, giving thus a 12 m long illuminated surface per table, altogether 24 m. In the near future, however, each room will be equipped with two illuminating tables, doubling thus the total illuminated surface. We use long vertical Osram tubes, about 20 cm back of the opaque glass on either side. They are daylight tubes, and their light is not inconvenient to the eyes, so that the films need not be screened off. Colorless films are more suitable for daylight than are blue films, which are particularly suitable for yellow light. *The light-cabinets are elevated about 6 cm above the tables*, so that films and envelopes may be pushed nearly 20 cm in under the cabinets. Thus the surface of the table need not be so wide as to be inconvenient to the physician who reads the films by forcing him too far away from the films in front of the lamps. The surface of the table outside the light-cabinet is 42 cm which, together with the above-mentioned 20 cm under the cabinet, make a total width of 62 cm, which is very convenient, and still it keeps the opaque glass at an agreeable distance from the physician reading the films. At suitable intervals, the table-top is equipped with *projectors with iris diaphragm under opaque*

glass at the level of the table-top for the study of particularly dark films. This construction of the light-cabinets has now been adopted in many clinics.

Next to one of the large reading rooms the secretaries have a room, the door-frame of which is equipped with a box system allowing the various departments of the hospital to collect their films without disturbing the secretaries in their work.

The Roentgen Therapeutic Department

As mentioned already, this section is situated in the storey under the diagnostic department. It comprises a large waiting-room, a secretarial room, 3 examining rooms (one of them for gynecological examinations), and 3 therapeutic machines, each of which is connected with two therapeutic rooms. Each therapeutic room has 2 dressing-cabins. This department further includes a ward planned to accomodate 12 patients confined to bed (6 patients in each room).

In the therapeutic rooms the nurses are sitting with their backs towards the windows. This arrangement offers several advantages beyond the system after which the nurses are sitting in a hall, facing the daylight and liable to disturbance from passers-by, without access to fresh air, etc.

Of accessory apparatuses, mention is here to be made merely of a *stand for protection of the patient's head from the action of the roentgen rays:* a piece of lead-rubber sheet fastened to a wooden plate by means of a single screw and movable up and down as well as back and forth. The lead-rubber sheet hangs over the edge of the wooden plate; it can hang straight down or be turned obliquely and fastened to the patient's clothes by means of clothes-pegs, or it may be fastened to other pieces of lead-rubber sheet placed on the patient. This apparatus offers several advantages above the boxes or protecting systems resting on the patient, *e. g.:* it does not become displaced, it exerts no pressure on the head of the patient, and it gives no sensation of enclosure. Any cabinet-maker can make such a stand.

In my opinion, it is of the very greatest importance that *every dose is measured as carefully as possible*, and that the measuring technique is not liable to error. In many roentgen clinics merely a clock is used for this purpose — in the belief that it is safe to reckon that in the same length of time the same dose is given on employment of the same filter and the same distance, the roentgenologist relying on the functional stability of the apparatuses. But such a technique does not exclude the possibility that the nurse may employ a wrong filter or focus at a wrong distance. She may direct the central ray erroneously, or there may be

some error in the diaphragm, or some trouble may arise in the apparatus during the work without this being noticed, when merely the time control is used for the measuring of the dose. Indeed, the checking up control of the apparatus by a physicist every month or a few times a year, or the daily or weekly control by means of a Küstner apparatus, does not exclude the above-mentioned or similar sources of error. (Of course, we also employ a regular control of the apparatuses by a technical expert as well as by a physicist.)

In the Bispebjerg Hospital we have adopted the following procedure: Every dose is measured with the Baastrup-Johnsen dosi- and intensimeter. Such a measuring device is attached to each of our 6 couches for treatment.

1. We have tabulations worked out by the University Institute of Biophysics (RØNNE NIELSEN, Ph. D.). They show how long it takes to give a definite dose with a definite filter and focus distance. The nurse enters in the case record of the patient the period corresponding to the dose prescribed.

2. The intensity is read on the dosimeter and entered in the record; besides, the dose prescribed is divided by the intensity read. The intensity varies a little from one day to another, and thus it is practicable to control that the nurse does not simply copy the values recorded for the preceding treatment or from Rønne Nielsen's tabulation. This has happened once and was discovered immediately.

3. The automatic clock marks the time from the commencement of the irradiation till the dosimeter shows that the dose is reached. This time is recorded, too.

It happens but seldom that the three values recorded for 1, 2 and 3 turn out completely identical, varying usually up to 10 % either way.

The dosimeter may also be adjusted to completely automatic function, breaking off the current in the therapeutic apparatus when the dose is reached. Personally, I prefer the semiautomatic dosimetry described above, which makes it necessary for the nurse to keep alert and watchful. For the same reason, if fully automatic dosimetry is to be employed, the dosimeter ought to be connected with an alarm-clock.

During the 16 years in which I have employed this system — which I have not described before — it has never failed, and several times it has even disclosed some error in the work of the nurses or in the yielding capacity of the apparatus. How many times it has informed the nurses that they were employing a wrong filter or had made an error in adjusting the focus-skin distance, of course, is something I know nothing about. In practice, this system is very simple — so simple that any new nurse is able to learn it within her first day of service.

As no detailed description of the Baastrup-Johnsen dosi- and intensimeter has been given previously in the literature, it will be appropriate here to insert a brief description of it from Dansk Røntgen Teknik A/S.

Description of the »Baastrup-Johnsen» Roentgen Dosimeter

Principle.

The roentgen-radiation sets up an ionization of the air in a highly insulated ionization chamber, K, of a few ccm's volume. Thereby a current is set up between the graphitized inner wall of the measuring chamber and the pin-shaped central electrode, in the order of magnitude of 10^{-8}—10^{-9} Amp.

The voltage of the electrodes in the ionization chamber is so selected that a saturation current is set up in the chamber, *i. e.*, a further increase of the voltage between the electrodes of the chamber effects no increase of the ionization current.

A measuring resistance of 500 megohms has been placed in series with the ionization chamber. The voltage drop formed at the 500 megohm resistance by the ionization current is led to the grid of the amplifying valve, DT 2. Thereby a milliammeter, M, registers an increase of the anode current. This increase is in turn compensated by leading to the grid of the amplifying valve an equal and oppositely directed voltage as the one the ionization current has produced over the 500 megohm resistance. This compensation voltage works in series with the above-mentioned resistance and is taken out by means of a variable potentiometer, P 2.

The ionization current, and thereby the voltage drop over the measuring resistance, is proportional to the intensity of the roentgen radiation measured in r/min. The compensation voltage is, therefore, also proportional to the intensity in r/min.

A voltmeter, V, that shows the compensation voltage can be adjusted in r/min., and an ordinary d. c. electricity-meter, J, connected to this voltage can be brought to show the applied amount of radiation during a certain period.

The Ionization Chamber.

The ionization chamber, K, is placed in the end of the chamber holder, which consists of a Pertinax tube with a wall thickness of 1 mm. In the centre of the chamber lies a bamboo pin, B, 3 mms thick, which forms one of the electrodes. The inside of the thimble chamber and the bamboo pin is graphitized in order to make it conductive. A thin layer of aluminium has been sprayed on the outside of the chamber holder, which is connected to the graphitized inside of the chamber and at the same time with the metal housing which connects the amplifying valve. In this way the inside of the chamber is connected to earth, and has + potential against the central electrode.

The central electrode is connected to the grid of the amplifying valve, which is connected to the 500 megohm resistance as well. The central pin is led through an inner tube, R, which is filled with powdered colophony, thus securing that an ionization of the air space in the chamber cannot develop a false ionization current. The central pin demands a very fine electrical insulation and is therefore placed in an amber insulation, R.

The amplifying valve, DT 2, is placed as near the chamber as possible in order to avoid the difficulty in insulating the connecting cable between the amplifier and the chamber, and furthermore avoiding the capacitive damping from a long connecting cable. Furthermore, it is easier to instal the cables leading to the chamber, as they can be built into the walls.

The Control Table.

A 4-volt accumulator supplies the dosimeter with current over the switch relay, A, which is fitted with a press button (start-stop). The resistances P1 and P2 in series are made as a potentiometer, from the sliding finger of which the variable compensation voltage is taken off.

On the instrument, on the left hand side of the control table (called O-instrument) the anode current is adjusted by means of a rheostate, D, in the heating circuit of the amplifying valve at a fixed O-value, which is marked with a red line. As soon as the chamber is irradiated, the anode current of the amplifying valve is increased, and the pointer of the instrument moves to the right.

By means of the controlling handle, which can be found below the other instrument which indicates r/min., the pointer of the O-instrument is brought back to the red line. Thereby the intensity measuring instrument indicates the dose in r/min.

On the dose instrument, on top of the control table the desired roentgen dose can be pre-adjusted. A pointer, F, can be adjusted to the desired dose and remains fixed there. Gradually as the dose goes off, a second pointer, G, moves against the fixed pointer so that the momentary position of the pointer indicates the dose given. When the dose has been applied, a contact is made, a buzzer sounds, and the dosimeter is switched off automatically.

A control of the instrument has shown that the indication is practically not influenced by the penetration of the radiation, even at low tensions.

The intensity measuring instrument can measure up to 75 r/min, the total-dose instrument up to 400 r.

SUMMARY

A description is given of various contrivances and procedures adopted in the new roentgenological department of the Bispebjerg Hospital, Copenhagen, Denmark.

Presumably, the main interest is attached to the color of the light in the fluoroscopy rooms (the same color of the light as that of the fluoroscopic screen is least inconvenient to the adaptation), the light-cabinets, the projectors for the reading of the roentgenograms and the method for measuring of the therapeutic roentgen doses.

ZUSAMMENFASSUNG

Es werden die verschiedenen neuartigen Einrichtungen und Verfahren beschrieben, die in der neuen Röntgen-Abteilung am Bispebjerg Hospital, Kopenhagen, Dänemark Verwendung finden.

Zusammenfassend kann gesagt werden, dass das Hauptgewicht auf die Farbe der Beleuchtung in den Räumen für die Durchleuchtung gelegt wird (diejenige Farbe der Beleuchtung, die der Lichtfarbe des Durchleuchtungsschirmes gleicht, wirkt am wenigsten störend für die Adaption), auf die Leuchtkästen, auf die Projektionseinrichtungen zum Lesen der Röntgenbilder und auf das Verfahren zur Messung der therapeutischen Röntgendosis.

RÉSUMÉ

Description de divers arrangements et procédés adoptés à la nouvelle division radiologique de l'Hôpital Bispebjerg, Copenhague, Danemark.

Ce qui, probablement, mérite le plus d'intérêt, c'est la couleur de l'éclairage des salles de radioscopie (une lumière de la même couleur que celle des écrans fluorescents gêne le moins l'adaptation), les cabines lumineuses, les projecteurs pour la lecture des radiographies, et enfin la méthode de mesure des doses thérapeutiques de Rayons de Roentgen.

FROM THE RADIOTHERAPY DEPARTMENT (CHIEF: DOCENT HUGO AHLBOM) AND THE CENTRAL CLINICAL LABORATORY (CHIEF: DOCENT GRETA HAMMARSTEN) OF SÖDERSJUKHUSET, STOCKHOLM, SWEDEN.

PLATELET VALUES IN PERSONNEL ENGAGED IN ROENTGEN DIAGNOSTIC WORK[1]

by

Harry Mossberg

Information in the literature regarding blood injuries amongst personnel in radiologic work is rather scanty and not in accordance. Practically all known changes, both regards quality and quantity, in the white blood picture, are reported. Some authors, however, consider that no definite difference between the white blood picture of persons occupied in radiologic work and that of persons not exposed to radiation can be noted.

I have not been able to find any reports concerning the platelets in the literature on professional blood changes due to irradiation.

KAUFMANN (1946) used the prothrombin time as an indicator of radiation damage. A prolongation of the prothrombin time by 50 per cent gave a sign for caution and a prolongation by 100 per cent or more in one case was supposed to indicate a real damage. The person in question had temporarily to leave his radiologic occupation. In the same paper KAUFMANN expressed the opinion that the thrombocytes were very resistant against roentgen rays.

NORDENSON's extensive investigation, published in this journal in 1946, of the changes in the white blood picture of personnel engaged in radiologic work, comprises the hitherto largest material, including 1,566 individuals and 29,000 registered examinations. He found a propensity to polycythaemia in both sexes, and, among women, perhaps a slight tendency to anaemia. The white blood picture showed a tendency to

[1] Read at the Meeting of the Northern Association for Medical Radiology, June 10—12, 1949; submitted for publication May 27, 1950.

leucopenia and a considerable 'shift to the left'. There appeared also a certain eosinophilia and basophilia, the latter more marked than the first. No very serious cases of anaemia were observed in his series.

NORDENSON has later, on the basis of further studies, modified his evaluation of the white blood picture as expressed in the following principles:

A leucopenia of 4,000 or below is a certain sign of radiation damage. Consecutive values between 4,000 and 4,300 white cells indicate a suspected radiation damage.

Regarding the differential count only the percentage of the lymphocytes is of importance: Normal values lie between 20 and 40 per cent. The upper borderline value lies between 41 and 44 per cent and a definite pathologic value is present if the percentage is above 45 per cent. The lower borderline value lies between 16 and 20 per cent and if the percentage is 15 or below a definite pathologic value is present.

Since 1945 I have been interested in the behaviour of the thrombocytes in irradiated persons and have particularly studied thrombocytopenia following local irradiation. Early during this period I planned to examine a series of radiological workers in this respect. ENGELBRETH-HOLM's survey of the lethal cases following radiation injury was a further stimulant to this investigation. Because of various circumstances I have not been able to carry out this study until last year. The main obstacle was the difficulty in obtaining nurses with good training in counting the platelets.

KRISTENSON's method of counting the thrombocytes has been slightly modified during 1948 by LISA BOSTRÖM, and our experiences of this modification are, during the last two years, very good. The values are now very reliable, and the platelet count is, in our opinion, a more reliable and valuable means of following the general reaction of patients receiving deep roentgen therapy for tumours, than the white cell count.

As it was probable that the personnel occupied in roentgen diagnostic work should show the greatest influence of radiation, I made platelet counts on 24 persons of the staff of the two roentgen diagnostic departments of the hospital. Three consecutive counts were made on three persons, and on 21 two counts were made. The average number of platelets was then determined for each individual. Also the corresponding white cell counts were registered.

The control material consisted of 16 persons, physicians and nurses, who had never been occupied in radiologic work or had only had such an occupation for a few months.

The Modified Kristenson Method of the Thrombocyte Count

Material and equipment:

Diluting fluid:

Urea	10.0 g
Sodium citrate	2.5 g
Mercury bichloride	0.005 g
Distilled water	500.0 g
Brillant cresyl blue	0.5 g

Olive oil-ether:

Olive oil	8.0 ml
Ether	200.0 ml

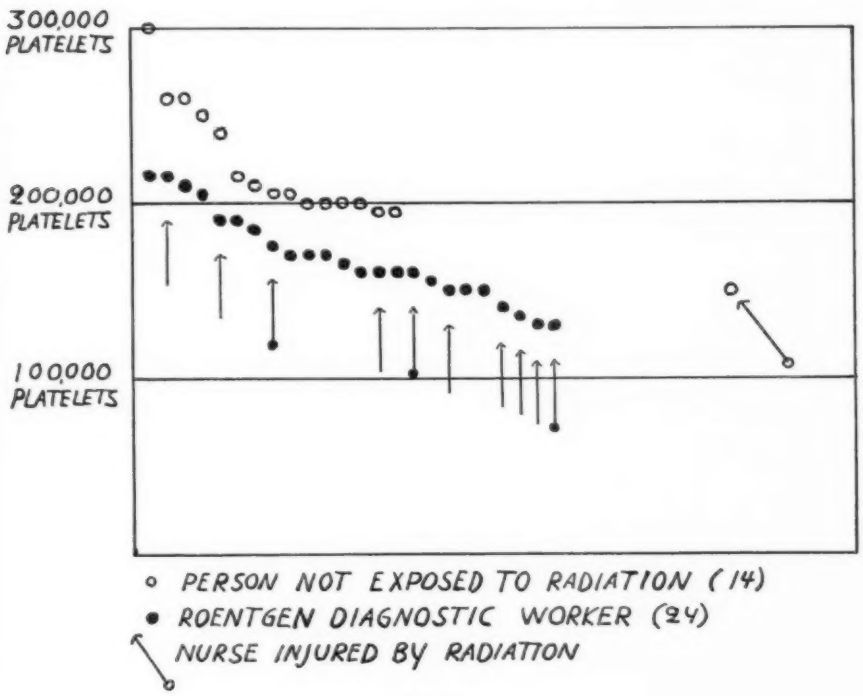
Procedure: A few ml of the diluting fluid are filtered immediately before the measuring off of the fluid. 225 mm^3 of the diluting fluid are measured off with a specially constructed measuring pipette which is designed by Miss Lisa Boström and manufactured by Rudolf Grave, Stockholm. By means of this pipette an exact volume of 225 mm^3 can automatically be measured off.

These 225 mm^3 of the diluting fluid are emptied into an Ellerman tube.

An Ellerman capillary pipette with a graduation of 25 mm^3 is oiled by drawing olive oil-ether up and down a few times. Then the olive oil-ether should be carefully blown out. — A fairly deep puncture is made in the tip of a finger or in the lobe of an ear so as to obtain a sufficient bleeding. The first drops of the blood are wiped off, whereupon the skin is covered with olive oil-ether. Then the blood is again wiped off by means of a piece of cotton-wool, so that the oil remains surrounding the puncture. The bleeding is increased by a slight stasis and the blood is promptly drawn up into the capillary pipette until a little above the mark, indicating a volume of 25 mm^3. The tip of the pipette is wiped off and the level of the blood is exactly adjusted to the mark through withdrawing a little amount of blood with a dry finger. The blood is emptied into the Ellerman tube, in which the tip of the pipette is placed against the bottom of the tube. The blowing-out of the pipette must be done rather rapidly in order to produce a moderate bubbling. The pipette is rinsed a few times and is then well blown out. The tube is corked and rolled between the palms of the hands in order to distribute the thrombocytes well. — A part of the fluid, sufficient to fill up a Bürker counting chamber, is immediately drawn up into the same pipette and transferred into the counting chamber, which is left standing in a moist chamber for 30 minutes to allow the platelets to settle before counting.

The Ellerman tube must not be tipped so that the fluid comes into contact with the cork, or is spread over a large area of the glass. This is important, because such a handling of the tube will cause too low thrombocyte values. If the Ellerman tube has been left standing and sedimentation has occurred, the tube must be rolled in upright position so that a good distribution of the thrombocytes is obtained.

The thrombocytes appear as light blue-coloured, light-refracting dots. The platelets are counted in 8 C—D squares. The total number is multiplied with 1,000 and the number of platelets per mm^3 is obtained.



Figure

↕ = definite pathologic changes in the white blood picture, according to NORDENSON, *i. e.* a leucopenia of 4,000 cells or below and/or a definitely pathologic differential count.

↑ = suspected pathologic changes in the white blood picture, *i. e.* consecutive values between 4,000 and 4,300 white cells and/or an uncertain pathologic differential count.

The figure shows the results of the platelet counts. As seen from this figure the platelet counts of the control persons lie between 300,000 and 195,000 which are normal values.

The average platelet counts of the roentgen diagnostic personnel vary between 215,000 and 130,000 with a lowest registered count of 115,000. Sixteen persons had a platelet count of 170,000 or below and seven of these sixteen persons had a platelet count of 150,000 or below. Two had only 130,000 platelets.

In the control material one of the nurses had a platelet count of only 150,000. (Marked in the figure with ↖.) When I asked her about her previous occupation, she said that she five years ago had had a radiation injury to the blood, acquired during a relatively short period of roentgen diagnostic work. At the time of the injury (1944) the platelet count was said to have been 20,000 and the leucocyte count 700. One year later the thrombocyte values varied between 40,000 and 70,000; after two years she had between 80,000 and 100,000 platelets, and three years after the injury she had about 110,000 platelets. The differential count showed no alterations.

Estimation of the Trombocyte Values

The normal thrombocyte values of the method used lie between 200,000 and 400,000. A thrombocytopenia is present, according to NORDENSON, only if there is one value considerably below 100,000, or if there are two or more values below 100,000. A definite decrease in the platelet count is present, according to our experience of the thrombocyte control of a large material — including patients treated with deep roentgen therapy — if the thrombocyte values lie about 150,000 or below. A suspected influence on the thrombocytes is present if there is a decrease to values between 170,000 and 150,000.[1]

Seven persons out of twenty-four thus showed a definite decrease in the platelet count, and nine an uncertain influence of radiation. The remaining eight persons had normal platelet values. The relationship between the thrombocyte values and the changes in the white blood picture is as follows:

There were four cases with uncertain, and one with definite pathologic changes in the white blood picture, among seven persons with definite influence of radiation on the platelets.

In a group of nine persons who showed an uncertain influence of radiation on the platelets, one presented definite, and one uncertain changes in the white blood picture.

[1] Regarding the reliability of the method see MOSSBERG, Acta Radiol., Suppl. LXVII, 1947.

Three of eight persons with normal thrombocyte values showed changes in the white blood picture. Two of them had uncertain and one definite pathologic alterations.

On account of these findings I am of the opinion that the platelet count should be used as an integral part of the routine blood control of personnel, engaged in radiologic work. The platelet count is indeed time-consuming and technically difficult, but it seems to offer such great advantages that the hesitation in using the method must be overcome. In healthy persons the thrombocytes are very resistant against different external factors such as fever, infection and exertion. A low platelet count in an otherwise healthy individual in radiologic work must therefore be considered as a radiation effect. Changes in the white blood picture sometimes have other causes and also require a more detailed investigation for the diagnosis of radiation influence. The thrombocyte count is, of course, intended to be a complement to the necessary routine blood examination of personnel in radiologic work.

The blood findings of the aforementioned nurse who had received a radiation injury, emphasize the importance of such successive control of the platelets, and also show the long lasting effect of radiation damage to the blood and the blood-forming organs.

Further investigations of a larger number of personnel in roentgen diagnostic and therapeutic occupation, will show the value of a continuous control of the thrombocytes during a long period of time, and perhaps increase our possibilities to discover radiation damage to the blood and find out better protective means against the influence of radiation.

SUMMARY

Among personnel occupied in roentgen diagnostic work the author has found a definite decrease in the platelet count in about one third of the cases. On account of these findings the author is of the opinion that the platelet count should be used as an integral part of the routine blood control of personnel, engaged in radiologic work.

ZUSAMMENFASSUNG

Bei dem mit radiologischen Arbeiten beschäftigten Personal hat der Verfasser in etwa einem Drittel der Fälle eine Herabsetzung der Thrombocytenzahl festgestellt. Auf Grund dieses Untersuchungsergebnisses vertritt der Verfasser die Auffassung, dass die Thrombocyten-Zählung zu der regelmässigen Blutkontrolle bei dem mit radiologischen Arbeiten beschäftigten Personal gehören sollte.

RÉSUMÉ

L'auteur a trouvé une diminution du nombre des thrombocytes environ chez un tiers du personnel s'occupant de radiologie. Sur la base de cette constatation il estime que la numération des plaquettes doit faire partie du contrôle hématologique régulier auquel est soumis ce personnel.

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ROENTGEN DIAGNOSIS OF TUBERCULOUS SALPINGITIS[1]

by

Kristina Ekengren and *Åke B. V. Rydén*

Genital tuberculosis in women, which was formerly considered to be rare, has according to the latest investigations proved to be a rather common affection. In the form in which it most frequently occurs, the disease runs its course without any subjective trouble and does not cause any deviations from the normal that are demonstrable in connection with a palpatory genital examination. The symptom that in the majority of these cases causes the patient to seek medical advice is a shorter or longer period of sterility. But even in those cases in which the tuberculous genital changes are more advanced — as a rule due to caseous processes in adnexa — and in which it is possible for the examiner to diagnose the inflammatory adnex tumours by palpation, there is nothing characteristic for tuberculosis and still less anything that might be taken as proof, either as regards the symptomatology or palpatory genital finds. It is only possible to make the diagnosis of tuberculous salpingitis by a histological or bacteriological demonstration of tuberculous changes, either in adnexa or in the endometrium — there is no such thing as an isolated tuberculous endometritis without an earlier or simultaneous tubal tuberculosis. It is also frequently impossible to show the tuberculous nature of the adnexal changes observed in connection with a laparotomy. A tuberculous salpingitis demonstrated by microscopical examination of the removed tube thus often comes as an unexpected surprise. Nor can culdoscopy be said to have increased to any extent worth mentioning the possibility of making a reliable preoperative diagnosis.

[1] Submitted for publication, June 15, 1950.

Every addition to the diagnostic possibilities as regards genital tuberculosis in women must therefore be greeted with satisfaction.

Attention was drawn to such a possibility by MAGNUSSON (1945) when he pointed out that it was in the majority of cases possible to make a probable diagnosis of tubal tuberculosis by roentgen examination. SCHULTZE (1939) and KJELLBERG (1942) considered themselves unable to distinguish inflammatory tubal changes of different etiology through salpingography. In two publications, however, MAGNUSSON (1945 and 1947) showed in a material of 19 definitely established cases of tubal tuberculosis that two forms that were typical for this disease could be distinguished. On the one hand cases with »finely jagged and ragged contours with small lumen-defects, and sometimes with abscess- and fistula-like excavations of the tubal lumen», and on the other hand cases with »straight and rigid contours of the lumen and often by a pipe-like configuration of the tube». After examining 20 definitely established cases of tubal tuberculosis, MADSEN (1947) remarks: »It is to be emphasized that even though there is probably no absolutely specific roentgenogram for tuberculous salpingitis, according to my observations the following features still are strongly indicative of the tuberculous nature of the lesion: 1) when the abdominal ostium is closed the tube is often considerably less dilated than in other etiological forms of sactosalpinges; 2) sometimes areas of calcifications are seen in the tube too.» On examining 12 cases of tuberculous salpingitis, DEUEL and DEUEL-ZOGG (1948) arrived at the same result as MAGNUSSON in his earlier publication. They pointed out, moreover, that these changes were localized predominantly to the distal part of the tube. In six cases KO-CHI SUN (1948) found the tubal change characteristic of a tuberculous salpingitis described by MAGNUSSON as a »pipe-like configuration». In a larger work KELLER (1948) quotes MADSEN and MAGNUSSON, but without any more detailed argument he considers their conclusions as uncertain. On the strength of 5 roentgenologically examined cases of tuberculous salpingitis FREDRIKSSON (1949) confirms MAGNUSSON's earlier view.

The Roentgen-diagnostic Department of Karolinska Sjukhuset, however, has a salpingography material with cases of tubal tuberculosis which is numerically in advance of all that has hitherto been published, and we have therefore considered it to be of interest to present the results of an investigation based upon this homogeneous material.

Own Investigations

The material comprises 75 cases of tubal tuberculosis roentgenologically examined and treated at Karolinska Sjukhuset during the period 1941—1950, in which the diagnosis was confirmed by the microscopical

demonstration of tuberculous changes either in the tubes or in the endometrium. As control material we used all the roentgenologically examined cases of tubal sterility from the period 1945—47 that on subsequent operation and microscopic examination had not shown tuberculous tubal changes. The control material consists of 95 cases.

Distribution in age-groups

	Tuberculous salpingites	Control material
20—24 years	4	4
25—29 »	19	30
30—34 »	33	39
35—39 »	15	16
40—44 »	3	6
45—49 »	1	

Of the 75 cases forming the tuberculous salpingitis material 55 had not exhibited any subjective trouble and on gynecological routine examination 64 cases showed no abnormal genital changes. For the 95 cases in the control material the corresponding figures are 85 and 81 respectively.

Roentgenological technique

SCHULTZE's set of instruments was used. In all cases water-soluble contrast medium has been employed, the last $2^1/_2$ years Umbradil Viscous H (Astra)[1] with addition of 200,000 Units Penicillin.

After an initial frontal survey view without contrast, contrast medium is injected under fluoroscopic control. Then an exposure is made in supine position, furthermore obliques to the right and left and one more frontal exposure. Between each exposure and under fluoroscopic control a refilling of contrast medium is made. Then a lateral view and two exposures with horizontal ray-direction in each side position are made, to ascertain, whether there is fluid content in the tubes and how the contrast is moving in the pelvic cavity. The total amount of contrast is as a rule 20—30 ml. If in the course of the examination a tubal spasm develops, the filling of the tubes will be defective. After intravenous injection of spasmolyticum there is generally a rapid change.

In order to be able to judge the morphological changes causing the pathological roentgen picture, in a number of operated cases the entirely or partly removed tubes were roentgenologically examined after contrast filling, and then immediately fixed. With the help of the roentgenogram thus obtained, different parts of the specimen were selected for serial section and compared with the roentgen picture.

[1] Umbradil + carboxymethylcellulose + 0.25 % xylocaine.

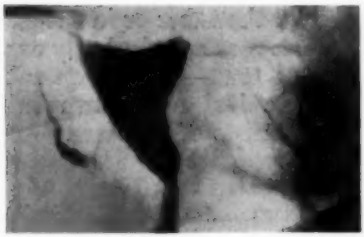


Fig. 1

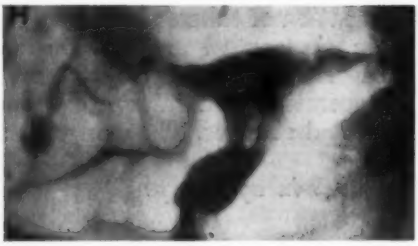


Fig. 2

Fig. 3

Fig. 4

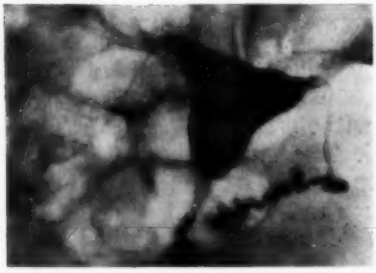


Fig. 5

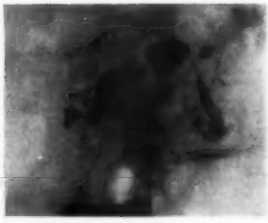


Fig. 6

Figs. 1—3: clublike tubes; group I.
(fig. 2: stricture in the right tube.)
Fig. 4: tuberculous tube; group II.
Figs. 5—6: multiple strictures; group III.
(fig. 6: strictures and recesses in the uterus. Compare uterine strictures of fig. 34 b. No filling of the right tube.)

Results

A. The *tuberculous salpingitis material* is typologically classifiable in the following groups:

I. Slightly dilated, club-like tubes with even contours and without mucous membrane relief, closed in the beginning of the ampulla or in

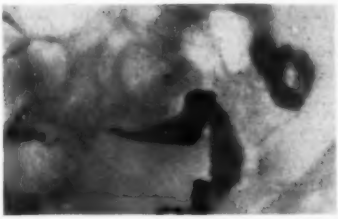


Fig. 7

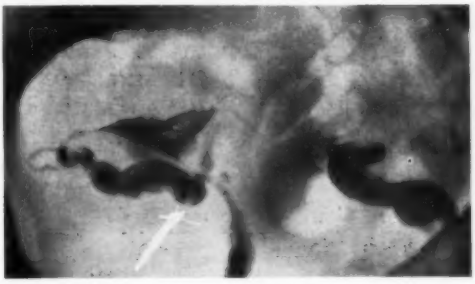


Fig. 8

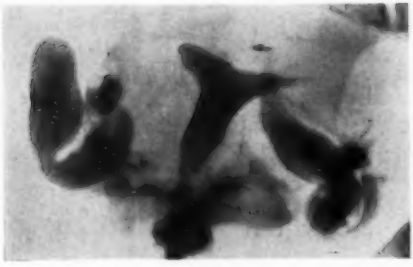


Fig. 9

Fig. 10

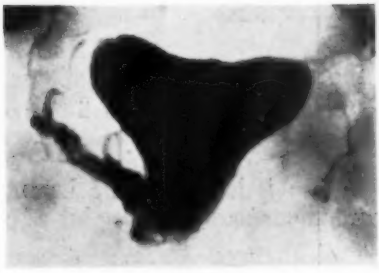


Fig. 11

Fig. 7: tuberculous changes; group I and IV.
Fig. 8—10: regular hypertrophic tubal ridges; group V.
Fig. 11: right tube group 6, left tube group I.

the isthmus (see figs. 1, 2, 3, 17, 18, 20 a, 26 a—b, 28 a—b, 29 a—c, 30 a—b, 31 b, 33 b, 34 b right, 35 b right, 36 a—b left);

bilateral changes ..... 18 cases
unilateral » ..... 11 cases

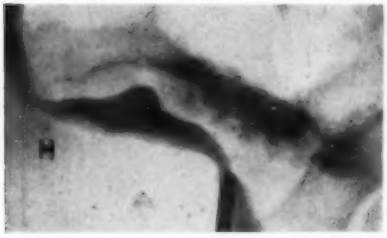


Fig. 12

Fig. 13

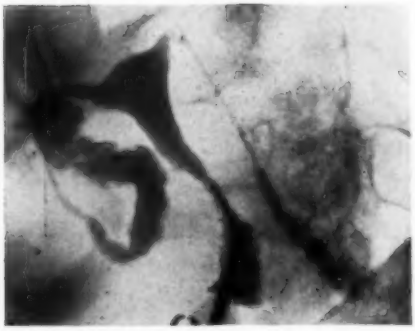


Fig. 14

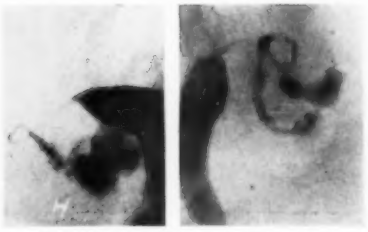


Fig. 15

Fig. 12—15: tuberculous changes; group VII.
(Fig. 14: in both tubes residues of iodine-oil after previous salpingography.)

II. Tubes closed in the isthmus or the beginning of the ampulla with an irregular or ragged contour at the point of occlusion (see fig. 4);

bilateral changes	.....	4 cases
unilateral »	.....	1 case

III. Tubes with multiple strictures in the ampullar or isthmical part (see figs. 5, 6, 31 a, 32 a—b, 33 a left, 34 b left, 35 b left, 36 b right);

bilateral changes	.....	7 cases
unilateral »	.....	14 »

IV. Moderately dilated tubes without mucous membrane relief in the ampulla (see fig. 7 left);

bilateral changes	.....	1 case
unilateral »	.....	4 cases

Fig. 16

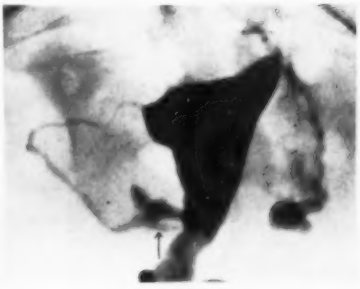


Fig. 17

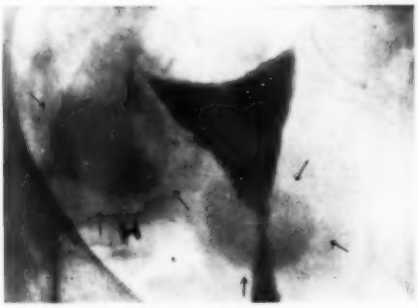


Fig. 18

Fig. 19

Fig. 16: fistula in distal part of right tube (arrow).
Fig. 17: fistula in distal part of right tube (arrow).
Fig. 18: big calcifications in both ovaries (arrows).
Fig. 19: small calcifications in distal part of left tube.

V. Dilated tubes with hypertrophic, longitudinal, regular mucous membrane relief in the ampulla (see figs. 8, 9, 10, 16 left, 23 a and e, 24 a, 38 a);

bilateral changes ..... 17 cases
unilateral » ..... 4 »

VI. Dilated tubes with irregular, hypertrophic mucous membrane relief in the ampulla (see figs. 11, 21 a, 27 a—b, 37 a);

bilateral changes ..... 6 cases
unilateral » ..... 3 »

VII. Slightly or moderately dilated tubes with ragged irregular contours and irregular contrast defects in the ampulla (see figs. 12, 13, 14, 15, 22 a, 25 a, 34 a left, 35 a left, 38 b);

bilateral changes ..... 6 cases
unilateral » ..... 4 »

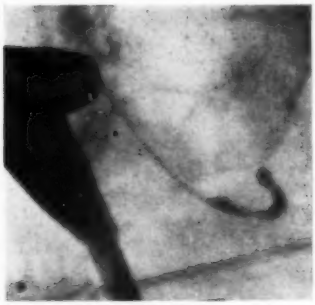


Fig. 20a

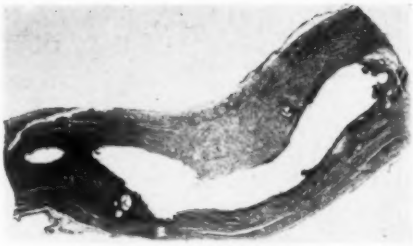


Fig. 20c

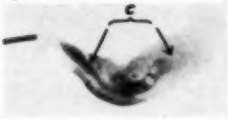


Fig. 20b

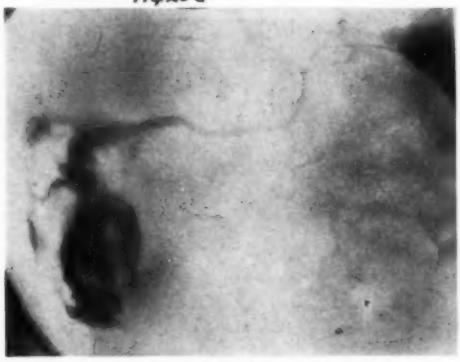


Fig. 21a

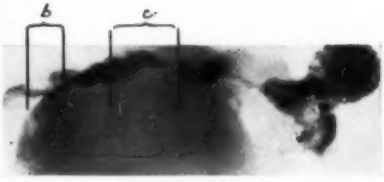


Fig. 22a

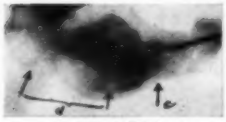


Fig. 21b

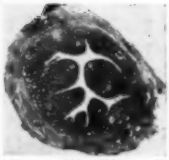


Fig. 21c

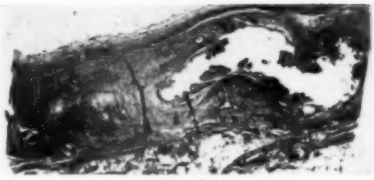


Fig. 22b

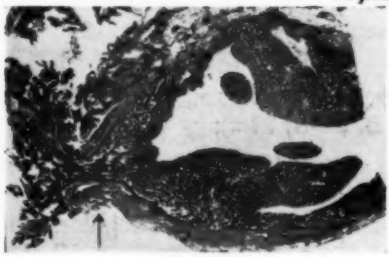


Fig. 21d

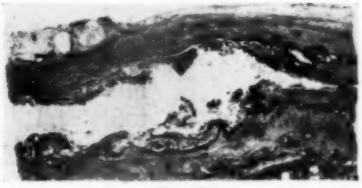


Fig. 22c

Fig. 20: a = salpingography, b = radiogram of the removed tube, c = microphotograph.

Fig. 21: a = salpingography, b = radiogram of the removed tube, c and d = microphotograph (stricture proximal to ostium at arrow).

Fig. 22: a = radiogram of the removed tube, b and c = microphotograph.

Fig. 23a

Fig. 23b

Fig. 23e

Fig. 23f

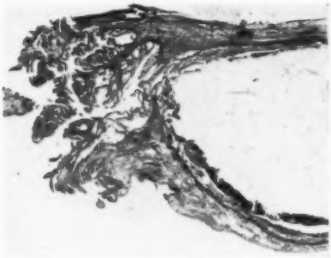


Fig. 23c

Fig. 23d

Fig. 23g

Fig. 23h

Fig. 23: a and e = salpingography of right and left tube, b and f = radiogram of right and left removed tube, c and d = microphotographs from right tube, g and h = microphotographs from left tube.

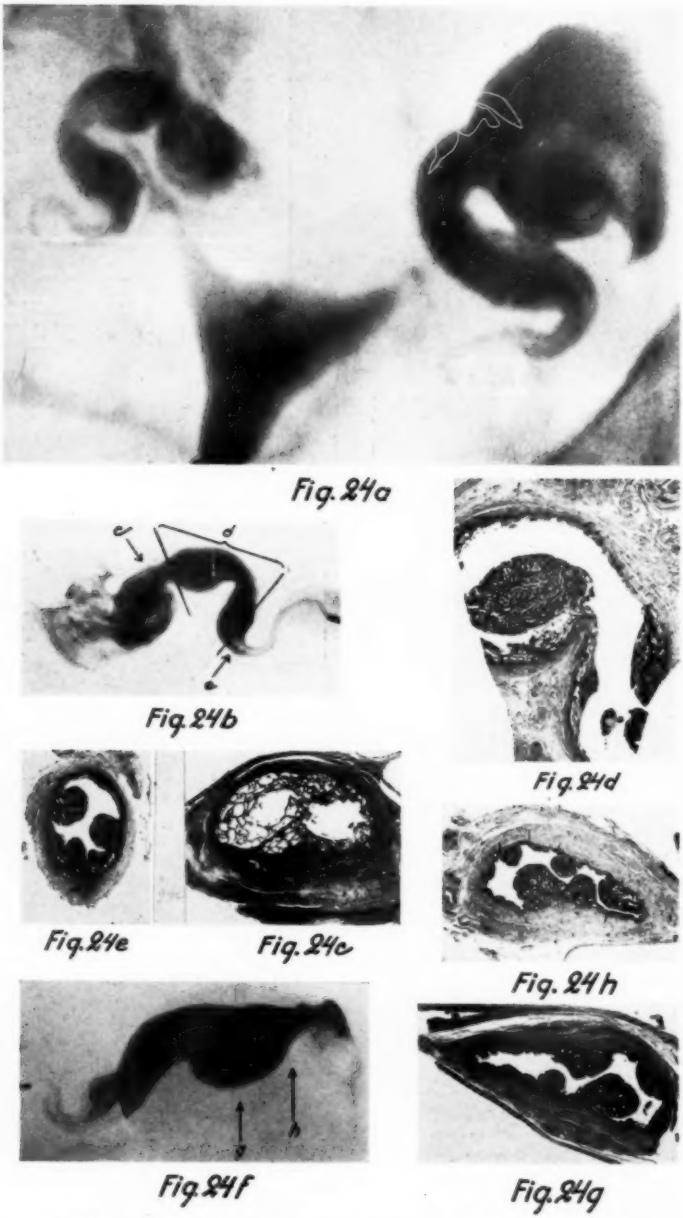


Fig. 24: a = salpingography, b and f = radiogram of right and left removed tube, c, d and e = microphotographs from right tube, g and h = microphotographs from left tube.

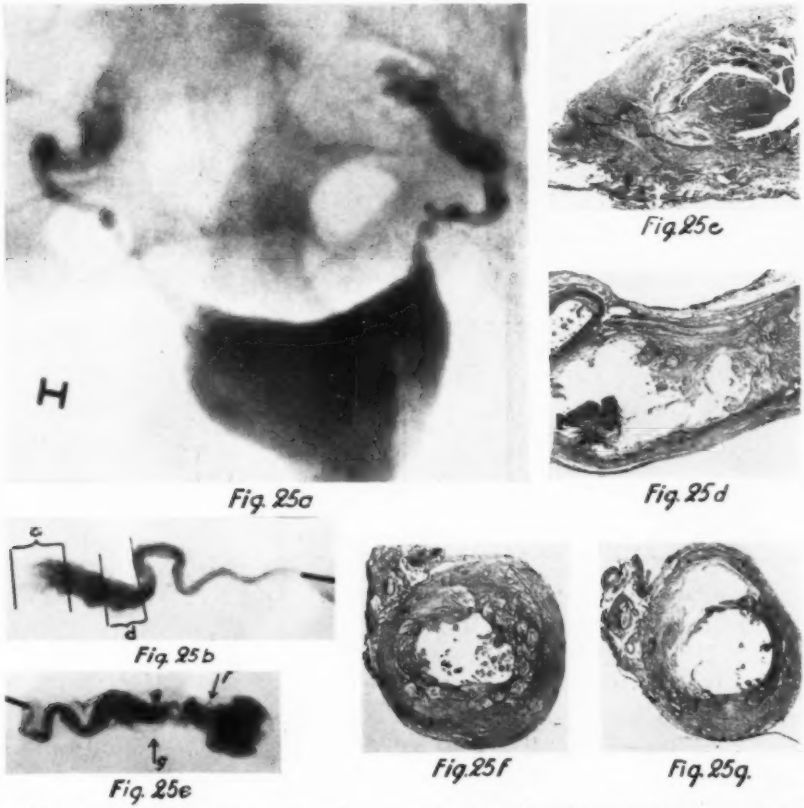


Fig. 25: a = salpingography, b and e = radiogram of right and left removed tube, c and d = microphotographs from right tube, f and g = microphotographs from left tube.

The material also includes cases with fistula-like formations (see figs. 16, 17) and intramural tubal recesses (see figs. 25 e, 28 a, 29 b, 30 a, 31 a, 32 a), as well as calcifications localized to the site of the tubes or the ovaries (see figs. 18, 19). These changes are found, however, in the majority of the above typological groups.

On examining the tubes removed by operation one gets an explanation of how the different details in the roentgen picture originate.

1. The tubes transformed to a club-like shape are conditioned by a connective tissue induration in the wall of the tube, whose lumen is closed by a connective-tissue scar, as a rule situated in the isthmus part or in the beginning of the ampullar part of the tube (see fig. 20 a, b, c).

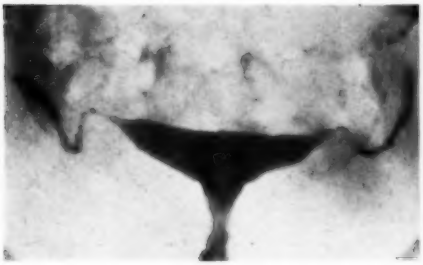


Fig. 26a

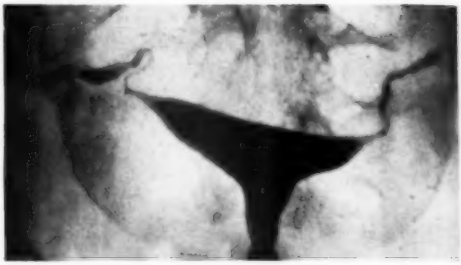


Fig. 26b

Fig. 27a

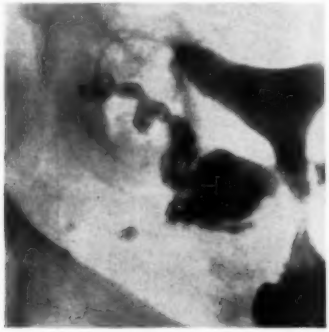


Fig. 27b

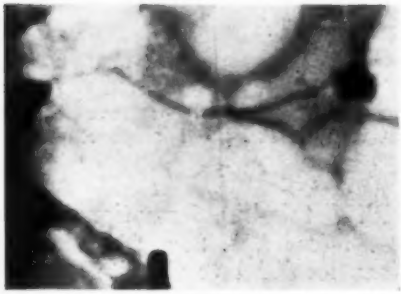


Fig. 28a

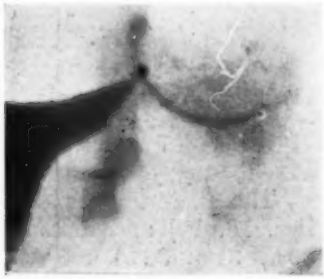


Fig. 28b

Fig. 26: a. Salpingography on 4. 10. 1946.
b. Same patient. Salpingography on 11. 10. 1949 after antibiotic treatment.
Fig. 27: a. Salpingography on 22. 9. 1949.
b. Same patient. Salpingography on 18. 1. 1950 after antibiotic treatment.
Fig. 28: a. Salpingography on 23. 4. 1947.
b. Same patient. Salpingography on 3. 5. 1949 after antibiotic treatment.

Fig. 29a

Fig. 29b

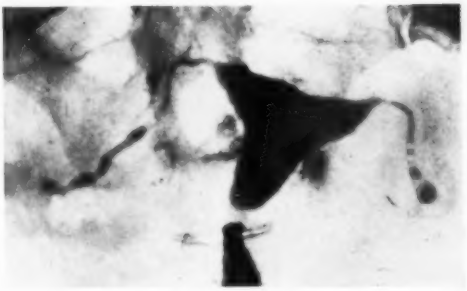


Fig. 29c

Fig. 30a

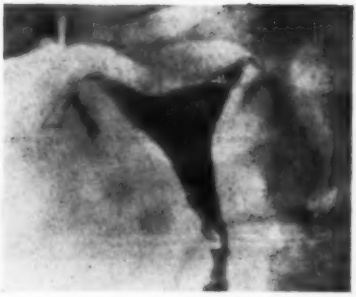


Fig. 30b

Fig. 29: a. Salpingography on 21. 2. 1944.
b. Same patient. Salpingography on 15. 11. 1949.
c. Same patient. Salpingography on 21. 4. 1950 after antibiotic treatment.

Fig. 30: a. Salpingography on 1. 4. 1949.
b. Same patient. Salpingography on 21. 11. 1949 after antibiotic treatment.

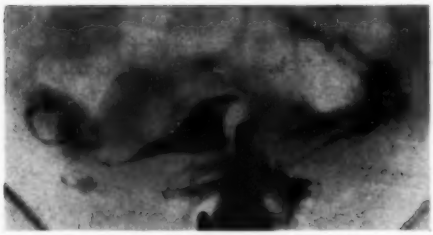


Fig. 31a

Fig. 31b

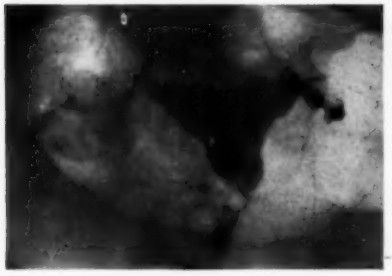


Fig. 32a

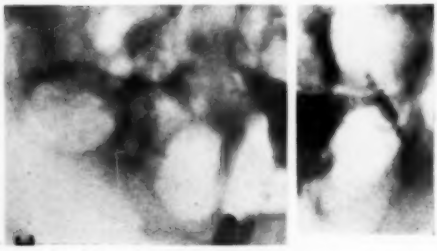


Fig. 32b

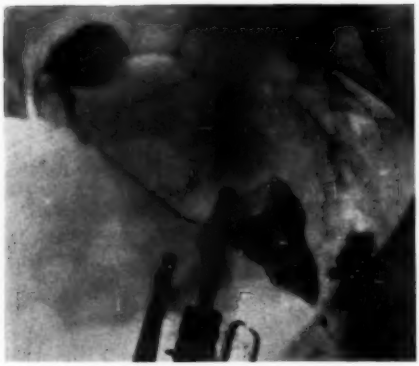


Fig. 33a

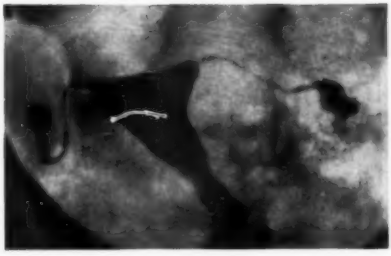


Fig. 33b

Fig. 31: a. Salpingography on 26. 8. 1941.
b. Same patient. Salpingography on 17. 9. 1946.
Fig. 32: a. Salpingography on 16. 8. 1948.
b. Same patient. Salpingography on 10. 10. 1949 after antibiotic treatment.
Fig. 33: a. Salpingography on 10. 11. 1948.
b. Same patient. Salpingography on 28. 2. 1950.

Fig. 34a

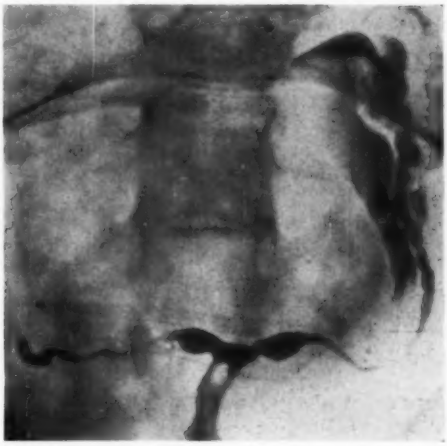


Fig. 34b

Fig. 35a

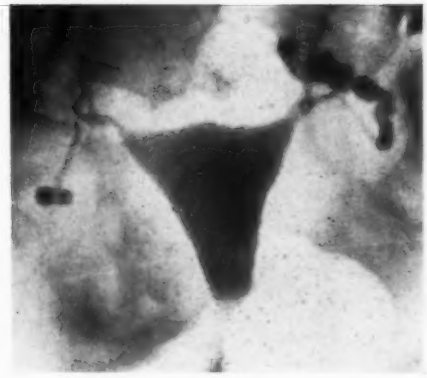


Fig. 35b

Fig. 34: a. Salpingography on 17. 8. 1946.
b. Same patient. Salpingography on 1. 3. 1949 after antibiotic treatment.
Fig. 35: a. Salpingography on 31. 3. 1948.
b. Same patient. Salpingography on 12. 1. 1949 after antibiotic treatment.

2. The tubal strictures are caused by connective-tissue scars consisting of tougher tissue than that of the rest of the tube (see figs. 21 d, 22 a, b, c).

3. The hypertrophic mucous membrane relief in the ampulla is caused by ridges, longitudinally to the tube, formed from the remnant hypertrophied villus formations. Between the ridges the villi

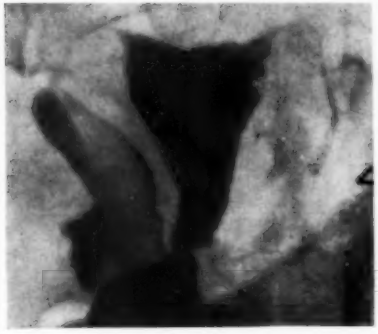


Fig. 36a

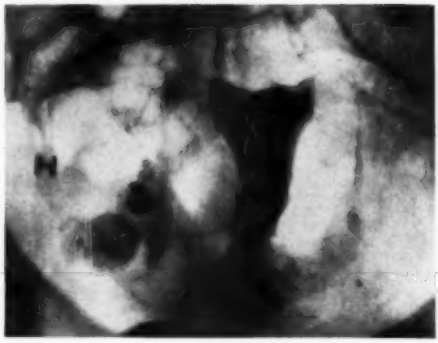


Fig. 36b

Fig. 37a

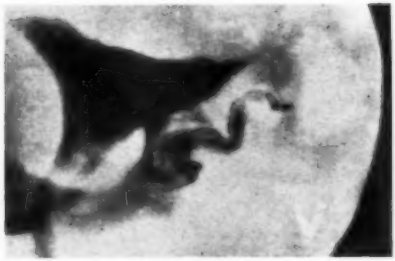


Fig. 37b

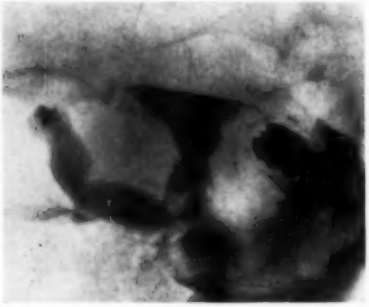


Fig. 38a

Fig. 38b

Fig. 36: a. Salpingography on 26. 10. 1948.
b. Same patient. Salpingography on 15. 4. 1949 after antibiotic treatment.
Fig. 37: a. Salpingography on 25. 1. 1949.
b. Same patient. Salpingography on 25. 4. 1949 after antibiotic treatment.
Fig. 38: a. Salpingography on 7. 11. 1942.
b. Same patient. Salpingography on 3. 2. 1948.

are entirely or to a very great extent destroyed (se figs. 21 a, b, c, 23, 24).

4. The gaps in the contrast are caused by isolated groups of hypertrophic villi, surrounded by parts where the villous structure is for the most part destroyed (see figs. 22 b, c, 25 c, d).

5. The ragged contrast-contours are conditioned partly by irregular groups of villi, partly by intramurally situated recesses, possibly also by deeper ulcerations of the mucous membrane (see figs. 22 a, b, c, 24 c, 25).

B. The *control material* is typologically classifiable in the following groups:

I. Much dilated sactosalpinges with no or only slight mucous-membrane relief;

bilateral changes ..... 53 cases

II. Moderately dilated sactosalpinges with no or only slight mucous-membrane relief;

bilateral changes ..... 17 cases

This group corresponds to group IV in the tuberculous material.

III. Dilated tubes with hypertrophic, longitudinal mucous-membrane relief in the ampulla;

bilateral changes ..... 16 cases

This group corresponds to group V in the tuberculous material.

IV. Dilated tubes with irregular, hypertrophic mucous-membrane relief in the ampulla;

bilateral changes ..... 3 cases

This group corresponds to group VI in the tuberculous material.

V. Tubes with multiple strictures in the ampullar part;

unilateral changes..... 1 case

This group corresponds to group III in the tuberculous material.

VI. Slightly dilated, club-shaped tubes with even contours and without mucous-membrane relief, closed in the beginning of the ampulla or in the isthmus;

bilateral changes ..... 2 cases

This group corresponds to group I in the tuberculous material.

VII. Tubes without dilatation or change in the mucous-membrane relief, closed in the isthmical or ampullar part. There is here operative verification showing an atresia due to malformation;

bilateral changes ..... 3 cases

The *permeability* of the tubes has in the various materials been as follows: in the tuberculous material there has been a passage of contrast to adhesion cavities or to the free abdominal cavity in 39 cases. The corresponding figures for the control material is 58 cases.

Discussion

On comparison of the two materials the following groups of salpingograms have proved typical for tuberculous salpingitis.

A. *Group I in the tuberculous material:* in the control material tubes with this appearance have been seen in only two cases.

Group II in the tuberculous material: nothing corresponding to these tubal changes has been seen in the control material.

Group III in the tuberculous material: in the control material these changes have been seen unilaterally in one case.

It must here be pointed out, however, that the cases in the control material referred to above may have a tuberculous etiology in spite of the fact that it was not possible to demonstrate microscopically any tubal tuberculosis, since these tubal changes, as will later be shown in connection with the development of the tuberculous salpingitis, imply advanced healing phases of the tuberculous process.

Group VII in the tuberculous material: similar cases have not been seen in the control material.

The above four groups are so typical for tubal tuberculosis that in cases with such tubal changes this diagnosis may be made roentgenologically with a high degree of probability.

B. *Group V in the tuberculous material:* tubes corresponding to this group have been found bilaterally in 16 cases of the control material.

Group VI in the tuberculous material: in the control material such tubal changes have been found bilaterally in 3 cases.

Salpingograms with the above appearance are more common among the tuberculous salpingitis than in the control material. Very pronounced hypertrophic ridges of the mucous membrane, however, are found only among the tuberculous salpingites. It is worth pointing out, moreover, that at operation one occasionally meets with cases in which the tubes have had this appearance on the roentgenogram, and in which the tuberculous nature of the tubal process is established by demonstration of a tuberculous endometritis, but in which in spite of this it has not been possible to verify the tubal tuberculosis microscopically. There are therefore among the controls doubtless a number of cases in which, in

spite of a negative microscopic examination, the etiology has been a tubal tuberculosis.

C. *Group IV in the tuberculous material:* among the controls bilateral changes corresponding to this group have been found in 17 cases.

Tubal changes of this appearance do not imply anything characteristic for tuberculosis.

The calcifications in the tubal or ovarian sites referred to earlier have not been found in any cases in the control material, and the same applies to the previously mentioned fistula formations and intramural tubal recesses. A demonstration of such findings thus provides very strong support for a tuberculous etiology of the tubal processes.

In the salpingographic material is seen another manifestation typical for tubal tuberculosis. The changes in the two tubes are of typologically essentially different kinds (*e. g.* right tube group VI, left tube group I, see fig. 11; right tube group I, left tube group VII, see fig. 35 a, or right tube group V, left tube group I, see fig. 36 a). This symptom also distinctly favours the assumption of a tuberculous salpingitis.

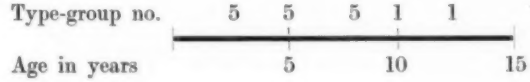
On the other hand, we have found among the controls cases of unilateral post-inflammatory tubal changes, in which the other tube has had a completely normal appearance. This type of roentgenogram, which has not occurred in the tuberculous material, speaks against a tuberculous genesis.

The main part of the controls show a roentgenological tubal picture that has not been seen in a single case among the tuberculous salpingites. This type of tubal changes shows bilateral, much dilated sactosalpinges, entirely or partly occluded in the fimbriate end with no or only slight mucous-membrane relief. These changes are typical for the final state after a pyosalpinx of gonorrheal or septic nature. Tubal changes of this type almost exclude the possibility of a tuberculous etiology.

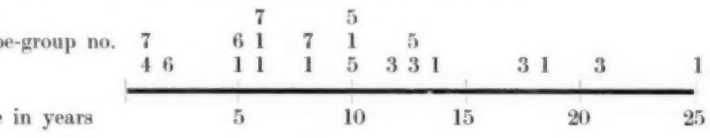
The age of the tuberculous changes.

The material affords the following possibilities of judging the age of the tubal process.

1. In five cases one or more pregnancies have preceded the salpingography. The time between this and the last pregnancy must be the maximum age for the tuberculous salpingitis. The cases are here represented graphically.



2. In 17 cases a definitely established tuberculous peritonitis and in 4 cases a skeletal or renal tuberculosis have preceded the salpingography. With the help of the interval of time a certain and a probable minimum age for the tubal tuberculosis may be concluded.



Both these calculations show, that the stricturating types of tubal tuberculosis (the groups 1, 2 and 3) certainly are the oldest.

It has in 27 cases been possible to study the *course of development* of the tubal tuberculosis in repeated salpingographies at intervals of at most 6 years. Of these cases the majority have undergone an antibiotic treatment with streptomycin, PAS or both substances combined.

In the great majority of cases where the tubal appearances have changed (see figs. 26 a—b, 27 a—b) the development has been a formation of multiple strictures or an increase of an earlier stricture forming process (see figs. 28 a—b, 29 a—c, 30 a—b, 31 a—b, 32 a—b, 33 a—b, 34 a—b, 35 a—b, 36 a—b). Both of these groups are of about the same size. In two cases there has been a return to normal of an earlier pathological roentgenogram (see figs. 37 a—b). In one untreated case (see figs. 38 a—b) renewed roentgen examination six years later has revealed a pronounced impairment.

In the group of cases with unchanged salpingograms we find a relatively large number of tuberculous tubes with the appearance that we have classified in group I. It is evident that the development goes via stricture formation, as a rule multiple, towards the final state that has been summarized in group I, »the tubes transformed to club-like shapes», and that the states classified in the groups I, II and III imply a healing process in different stages of advancement in the different groups.

It is furthermore probable that in the groups V and VI there may be cases in which the healing process is complete at this stage without any stricture formation having occurred.

Probably none of the typological groups in this investigation, however, contains any cases of fresh tubal tuberculosis.

It has been pointed out by different writers, RABAU, HALBRECHT and CASPER (1943), HALBRECHT (1946), O'BRIEN and LAWLER (1947), VABOIS (1948), RABAU, HERMAN and CASPER (1949) et al., that in cases of tubal tuberculosis a salpingography would entail a serious risk of an activation and spreading of the process. Altogether 119 salpingographies have been carried out in tuberculous salpingites. The only complication

in this connection has been a brief feverish state (38.3° C.) in one case, but then still without any signs of activation in the form of palpable adnexal tumours or any secondary spreading. A salpingography carried out according to the procedure above and with water-soluble contrast medium should thus not entail any risk worth mentioning.

In this connection it is as well to point out the considerable advantages of a water-soluble contrast medium as compared with an iodine-oil. Salpingography with such contrast implies a clearly unphysiological operation with minimal resorption of the contrast, and frequently directly misleading tubal pictures. A water-soluble contrast medium gives the most detailed salpingograms, and due to the low surface tension also small fistulas and recesses are filled and the contrast mixes with any tubal content that may be present. This is in a far lesser degree the case if an iodine-oil is used, and this contrast-rich medium obscures, moreover, important details in the tubal picture. The advantage of an increased viscosity of the water-soluble contrast medium is that the tubal evacuation is slowed up.

SUMMARY

Definitely established tubal tuberculosis has been studied roentgenologically in 75 cases and compared with a control material. The morphological changes that cause the salpingogram have been studied on roentgenograms of operative specimens which have been microscopically examined. It has been possible to distinguish 6 types of salpingograms which in a greater or lesser degree are characteristic for tubal tuberculosis. The development of a tubal tuberculosis has been studied in 27 cases with repeated salpingographies. Tubal tuberculosis heals as a rule with a shrinking of the tuberculous tissue, which in most cases leads to multiple constrictions of the tubal lumen and finally to an obliteration. Salpingography with a water-soluble contrast medium does not entail any risk worth mentioning of an activation or spreading of the process in cases of tubal tuberculosis.

ZUSAMMENFASSUNG

Tuben-Tuberkulose wurde bei 75 Fällen mit deutlichem Organbefall röntgenologisch eingehend untersucht und an Kontrollmaterial vergleichende Studien vorgenommen. Die morphologischen Veränderungen, die die Veranlassung für die Vornahme des Salpingogramms bildeten, wurden auf den Röntgenbildern von Operationsmaterial studiert, das seinerseits wieder mikroskopisch bearbeitet wurde.

Es ergab sich die Möglichkeit, 6 typische Arten von Salpingogrammen zu unterscheiden, die in mehr oder minder ausgesprochener Weise für die Tubartuberkulose kennzeichnend sind.

Der Verlauf von Tubartuberkulose wurde mit Hilfe wiederholt vorgenommener Salpingographie in 27 Fällen genau beobachtet.

Tubartuberkulose heilt in der Regel mit einer Schrumpfung des tuberkulösen Gewebes, die in den meisten Fällen zu multipler Striktur des Tuben-Lumens und schliesslich zu einem Tuben-Verschluss führt.

Die bei der Tuben-Tuberkulose mit einem wasserlöslichen Kontrastmittel durchgeführte Salpingographie ist mit keiner nennenswerten Gefahr für eine Aktionierung oder für eine weitere Ausbreitung des Krankheitsprozesses verbunden.

RÉSUMÉ

Soixante-quinze cas de tuberculose certaine des trompes ont été étudiés radiologiquement et comparés à un matériel de contrôle. Les altérations morphologiques qui conditionnent le salpingogramme ont été précisées sur les radiographies de pièces opératoires qui furent examinées au microscope.

Il a été possible de distinguer six types de salpingogrammes, caractéristiques, à un degré plus ou moins grand, de la tuberculose des trompes.

L'évolution de la tuberculose des trompes a été étudiée dans 27 cas par des salpingographies répétées.

La tuberculose des trompes guérit dans la règle en s'accompagnant d'une rétraction du tissu tuberculeux, ce qui dans la plupart des cas aboutit à des sténoses multiples du canal de l'organe et, pour finir, à son oblitération.

La salpingographie par le moyen d'une substance de contraste hydrosoluble ne comporte aucun risque digne de ce nom de voir le processus pathologique être activé ou s'étendre dans les cas de tuberculose des trompes.

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FROM THE DEPARTMENT OF ROENTGENOLOGY AT ULLEVÅL HOSPITAL, OSLO, NORWAY
(CHIEF: J. FRIMANN-DAHL, M. D.)

ELECTROLYTIC SILVER RECOVERY FROM FIXING BATHS IN USE[1]

by

Kåre Heiberg, M. D.

1 sq.m. unprocessed roentgen film contains about 20 grams of silver in the form of silver halides, of this 4—5 grams are reduced to metallic silver in the developer, forming the picture, while 15 grams are dissolved in the fixing bath.

For about 10 years silver has been recovered from exhausted fixing baths at the Roentgen Department, Ullevål Hospital, by the zinc dust method. The sludge containing silver and zinc, formed by this method, has been sent to a refiner for refining, but during the last years the cost of this refining has been steadily approaching the value of the silver.

The silver may, however, be recovered as metallic silver of high purity by electrolysis, and if this method is applied to fixing bath while in use, the fixing bath retains its fixing properties longer. From the literature on the subject, only to be found in motion picture engineering journals, one gets the impression that the method is complicated and needs expensive machinery. In roentgenographic literature nothing has been found on the subject.

Elaborate machinery for recovering silver by electrolysis from fixing baths has been developed, and is widely used in motion picture processing laboratories. The process is carried on under vigorous agitation in large cells with cathodes of Monel metal and carbon anodes. A heavy current of up to 300 Ampères is passed through the cell, and the silver is deposited as metallic silver at the cathode.

We have been experimenting with electrolysis of fixing baths since 1948, and becoming aware of certain finesses in the method, the gain has been increasing subsequently. In the beginning we recovered the silver from the fixing baths when they were exhausted, the fixing solution

[1] Submitted for publication, May 5, 1950.

being transferred to other tanks used as electrolytic cells. This is the simplest method, the initial cost of the necessary equipment is moderate. Before electrolysis is started, pH of the bath must be controlled and eventually corrected. After electrolysis is started, regulation of the current within certain limits and care every other day is needed. When the cathodes begin to turn grey, the silver is recovered, the solution is discarded and the electrolytic unit may be transferred to another tank.

Later we began recovering silver from the fixing baths while in use in the dark room. An electrolytic unit is placed in one of the fixing tanks after the regular working hours, at 2 o'clock, and left there until 8 o'clock next morning. This unit is in activity 18 hours of the twenty-four, and precipitates most of the silver dissolved in the fixing bath during the working hours. At the same time the fixing bath is rejuvenated and can be used longer.

No precision methods or instruments have been used in these experiments. For current measurements milliamperemeters of the kind used in radio work have been used, a low internal resistance, preferably below 0.5 ohms is essential. The density of fixing solutions has been taken by means of an hydrometer with density range from 1.1 to 1.2. The pH value has been determined by pH test paper, range 4 to 8. The silver content of solutions has been determined gravimetrically.

The fixing bath:

Two fixing tanks of 70 litres are in use during the regular working hours from 8 a. m. to 2 p. m. One of the tanks only is used for casual work after the regular working hours.

The fixing solution in use contains:
Sodium thiosulphate 300,
Potassium metabisulphite 30,
Water to make 1,000.
Fresh fixing solution has a spec. grav. of 1.17 and a pH value of 4.2.

Before electrolytic silver recovery was attempted, the fixing bath was considered exhausted after about 8 days' use. Examination of this exhausted fixing solution showed spec. grav. 1.117—1.122, pH 6.4—7, silver content 8—8.5 grams per litre.

Changes occurring in the fixer with use:

With use certain changes occur in the fixing solution which gradually retards the rate of fixing and ultimately causes the exhaustion of the bath. Some of these changes must be taken into consideration if electrolytic silver recovery and regeneration of the bath are attempted.

1) Accumulation of silver compounds and sodium halides.
2) Contamination with constituents from the developer, retained in the film gelatine after development, and carried over.
3) Dilution with water from the rinsing tank.

The action of sodium thiosulphate upon silver halides results in the formation of complex sodium argento-thiosulphates and sodium halides. The amount of silver complexes produced represents a loss of the fixing agent, and at a silver content of 8—8.5 grams per litre the fixing bath is practically exhausted. By applying electrolysis to the bath, the silver is removed from the solution and sodium thiosulphate is reformed. In this way one component causing exhaustion is kept down. The amount of sodium halides formed in the fixer also reduces the fixing properties of the bath, and its accumulation in the fixer finally limits the life of the fixing bath even though the silver content is low.

The admixture of developer to the fixing bath is detrimental mainly by its content of alkali. Being alkaline the developer will neutralize the acid in the fixer, apparent by a rise in the pH of the fixing solution. This contamination may be kept down by draining films well after development, and by thorough rinsing in fresh running water between development and fixation. The control of the pH proved to be of great importance in electrolysis of fixing solutions. In commercial electrodeposition the acidity of the plating solutions is considered to be of vital importance and is always taken into consideration. The necessity of pH control by electrolysis of fixing solutions is also pointed out by others. During the first experiments it often happened that the fixing bath turned a fluorescent greenish red brown, and that the cathodes later turned black. This was found due to formation of colloidal silver, and happened only when pH was near 7. This correlation being clear, we began to keep the pH below 6 by addition of dry potassium metabisulphite, and later we have experienced no mishap of this kind. The pH value of fixing baths in use is taken once a week by test paper. If a value of pH 6 is obtained, 15 grams of potassium metabisulphite are added per litre of solution. If a a value of 6.5 is obtained, 30 grams per litre of solution are added.

Another change occurring in the fixer with use is the dilution with water; water is carried over with films and frames from the rinse to the fixing tank, and fixing solution is carried over into the washing tank. The drop in spec. grav. from 1.17 to 1.12 indicates a loss of about 1/3 of the fixing salt, and this represents a corresponding loss of fixing properties. With the fixing solution lost is also its content of silver, on an average, 4 grams per litre. These losses may be kept down by draining films and frames well after rinsing and after fixation. The loss of silver is further reduced by keeping the silver content of the fixing bath on a

low level, by precipitating it electrolytically. We have tried to compensate for the dilution of the fixing bath by addition of dry fixing salt at intervals. When the fixing rate after about one week's use increases notably we use to add fixing salt until the specific gravity of 1.17 is restored. We don't do this more than 2 times as the fixer after so long use becomes too contaminated (alkaline halides etc.).

When the fixer after 1—2 times' addition of fixing salt fixes too slowly, we use to transfer the solution to other tanks where the rest of the silver is precipitated by other electrolytical units.

Current sources used.

In all cases where a heavy current is needed, we have been using a unit taking its current from the a. c. mains. This unit consists of a transformer, the secondary winding of which is tapped from 1 to 6 volts, a selenium rectifier, a rheostat, amperemeter and the necessary fuses. In connection with this external current source carbon has proved to be the only useful material for anodes. We have used carbon sticks of the kind used in bell elements, as a rule 1 or 2 together. The connection should lie above the fluid level, and preferably be of stainless steel. Each carbon stick carries a narrow fitting bag of canvas or similar material. The connection to the electrolytical unit is made by flexible cables and clips, the negative terminal of the rectifier unit being of course connected to the cathodes.

For smaller units we have often been using a modification of the well known zinc-copper unit sometimes used for silver recovery from exhausted fixing baths. This unit consists of a zinc plate and a copper plate bolted together, and precipitates the silver mainly in the form of sulphide. The potential difference arising between zinc and copper when placed in the same electrolyte supplies the current needed for electrolysis. The formation of silver sulphide is due to a too heavy current per sq.dm. cathode surface, passing through the solution. In order to control the current a rheostat and a milliamperemeter have been introduced between the electrodes. By maintaining the current under a certain limit the silver is precipitated as pure silver at the cathodes. The copper electrode has later been replaced by electrodes of stainless steel which is not corroded by the fixing solution.

During electrolysis the zinc plate is gradually corroded and insoluble zinc compounds together with some dark silver is precipitated at the zinc plate. In order to prevent these compounds from sludging the bath, the zinc plate must have a filter. In the beginning we used a canvas anode bag, later pasteboard envelopes have been used. They are made from two pieces of pasteboard about 24 × 30 cm., glued together by

plastic glue. The filter is fixed to the zinc plate by twine or clips. Non imbued pasteboard of 1—1.3 mm. thickness, having a certain degree of porosity is essential. A pasteboard of suitable porosity, is penetrated by the fixing solution, and the current rises to its maximum level in a few minutes. With a denser pasteboard, the current needs some hours to reach its maximum. With a too porous pasteboard, the current reaches its maximum simultaneously as the zinc plate with the filter is immersed in the bath, but it often happens that the fixing bath becomes sludged after some hours. We have been using the pasteboard accompanying the roentgen films in the boxes. The pasteboard filter should be made with great care, if it leaks, or if it falls off in the bath, the fixing bath will be sludged.

A piece of zinc 16×30 cm. (submersed in the bath 16×22 cm.) yields 0.5 amperes continuously for about 48 hours, or 1 ampere for 24 hours. Later the current tends to fall due to accumulation of zinc compounds and silver on the plate. The zinc plate then must be cleaned by steel-wool or a steel brush, and the filter envelope must be replaced by a new one. This zinc anode method has certain advantages. A selfcontained unit may be made, requiring no external connections. Such a unit can easily be cared for by unskilled personnel (dark room operators and nurses). The method is cheap too, 23 grams of zinc being exchanged by 108 grams of silver. One of its disadvantages is that some silver is precipitated as black powder mixed with zinc compounds at the anode. Most of the silver, however, is precipitated as pure silver at the cathodes.

Cathodes:

For cathodes, stainless steel of the acid resisting quality containing molybdenum has been used. This material is not corroded by the fixing solution. The thinnest obtainable one has been 0.7 mm., but 0.5 or 0.6 mm. would perhaps have been more suitable.

Different surfaces have been tried. Using a rough surface, it was found difficult to get the silver from the plates. With a polished surface the silver often fell off in the bath. A smooth unpolished surface was found to be the happy mean, the silver being easily taken off by bending the plates when it had attained a certain thickness.

Current density.

According to Faraday's first law the metal deposited at the cathodes is proportional to the current passing through the bath; this holds true within certain limits also when fixing bath is used as an electrolyte. On the other hand, experiences from electrodeposition teach that there is a correlation between the metal content of the electrolyte and the current

density that can safely be used, as a general rule a higher metal content permits a greater current density and increased rate of deposition.

In a fixing solution containing 2—3 grams silver per litre a current density of 12 milliamperes per sq.dm. cathode surface produced a white deposit of pure silver, while a current density of 14 m.A. per sq.dm. produced a dark deposit containing silver sulphide and after a few hours sludging of the bath. This dark deposit at the cathodes also appears when the silver content of the solution during electrolysis drops below 0.7 grams per litre.

If, the cathodes having turned dark, the current is reduced below the permissible limit before sludging of the bath has taken place, the dark deposit disappears and the cathodes become white in a few hours. The same happens if the unit (with dark cathodes) is transferred to another bath rich in silver.

The first time a unit is used or when it is used again after reaping, only half of the permissible current should be used until the cathodes are covered by a thin white film. After 24 hours the current can be increased to the maximum permissible.

Electrolytical units used.

The size of a unit must be computed according to the average daily amount of silver dissolved in the fixing bath, calculating that 1 sq.m. roentgen film leaves 15 grams silver in the bath.

Under the very best conditions of deposition 1 ampere hour will deposit 4.024 grams of silver. Using fixing bath as electrolyte we have usually obtained a current efficiency of 80—85 %. Calculating 80 % current efficiency, 1 ampere hour will deposit 3.2 grams. In order to deposit 15 grams, $15 : 3.2 = 4.6$ ampere hours are needed. That is about 250 milliamperes in 18 hours. It is safest to calculate 200 m.A. as some silver is lost with the fixing solution wasted, and the silver content of the solution should not be allowed to fall, it is safer if it rises slowly. Calculating 10 m.A. per sq.dm. cathode surface, 200 m.A. correspond to 20 sq.dm.

For the last year we have been using a unit (figs. 1 and 2) comprising 14 cathodes of stainless steel 15×45 cm. of which 15×40 cm. are submersed in the bath, this gives a total cathode-surface of 84 sq.dm. For anode we have been using a zinc plate 16×30 cm., or a carbon stick, if an external current source is used. This unit has been running at 1 ampere, corresponding to 12 m.A. per sq.dm. (at 14 m.A. per sq.dm. the cathodes turn dark). This unit has been in action 18 hours of the twenty-four and has produced about 1.5 kg. silver per month. The concentration of the fixing bath has been restored by addition of dry fixing

Fig. 1. The big unit, having an effective cathode surface of 84 sq.dm. A zinc anode with its envelope is hanging in the front.

Fig. 2. The big unit, resting in its wooden stand.

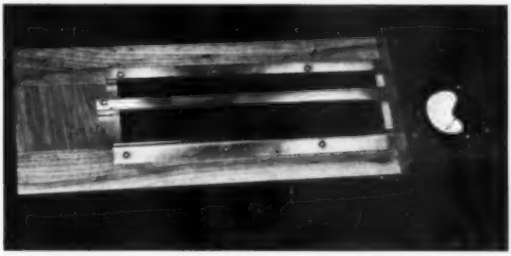

Fig. 3. The smallest unit, having an effective cathode surface of 24 sq.dm. The instrument box is fixed to the wood frame, and the connections are made inside the box. The angle iron in the middle is for the zinc plate, and the two lateral ones are for the cathodes.

salt to spec. grav. 1.17 once after 8 to 10 days' use, and the pH has been kept below 6 by addition of potassium metabisulphite. The fixing bath has been in use 2—3 weeks. Without regeneration it can be used 1 week.

The components of this unit are mounted on a wooden frame 39.5×25 cm. to suit the tank. The opening in the frame 30×15.5 suits the cathode

assembly. The cathode assembly is made of 2 stainless steel angle irons ($15 \times 15 \times 1$ mm.) 35 cm. long. Between these angle irons are welded 14 ribs made of the same material, spaced 2 cm. The vertical part of these ribs has 2 holes corresponding to two holes in the cathode plates. The cathodes are fixed by screws and nuts. The zinc plate is hanging on another angle iron, 8 cm. from the cathodes. The m.A. meter and the rheostat are mounted in a wooden box and are connected to the angle irons by flexible cables and clips. The filter envelope is discarded and replaced every day, and the zinc plate is brushed. When not in use the unit is placed in a wooden stand (fig. 2). In the other tank we have been using another unit made with the object of saving space, in order that most of the tank can be used for casual work in the afternoon and at night. This unit consists of 30 cathode plates 5×40 cm. The cathodes have a hole in each end, and all are placed on two axes and spaced 1 cm. by pieces of tubing. This cathode assembly is submersed in the bath, suspended under a wooden plate. The zinc anode hangs on its angle iron 5 cm. from the cathodes. This unit occupies 10 cm. of the tank and leaves 30 cm. for fixation. The instrument box hangs on the wall to be protected from drip and spill. The connection to the unit in the tank is made by flexible cables and clips. This unit has a total cathode surface of 60 sq.dm and runs at 600 m.A.

A smaller unit has also been made (fig. 3), corresponding to an average film consumption of 1—2 sq.m. per day. This unit consists of 2 cathodes 30×43 cm. fixed to angle irons spaced 8 cm. The zinc plate is placed between the cathodes. This unit has an effective cathode surface of 24 sq.dm., and is running at maximum 250 m.A.

It would be an advantage to use a fixing tank somewhat larger than needed for fixation and leave a unit there continuously. The cathode assembly can even be placed at the bottom of the tank if it is deep enough.

It is a good plan to start silver recovery when the fixing solution has attained a silver content of 2—3 grams per litre, and later try to keep the silver content on this level. Keeping the silver content above 2 grams per litre, there is no risk for the silver content dropping below the critical value in one night and an unwanted decomposition taking place. When the fixing bath has been in use 1/3 of the time before it is exhausted, it has a silver content of about 2.5 grams per litre. At this time we start silver recovery.

Silver recovery in agitated fixing baths.

The low current density permissible in a stationary bath is evidently due to the slow diffusion taking place. In commercial electrodeposition this is overcome by setting the electrodes in motion or by introducing air bubbles at the bottom of the trough.

We have made a unit comprising 8 cathodes 15 × 45 cm. 3 carbon anodes mounted 10 cm. from the edges of the cathodes. On the same wooden board was mounted a small electric motor rotating a long axis carrying a propeller placed below the plates near the bottom of the trough. The propeller has a diameter of 15 cm. and 4 wings. With this propeller rotating 2—3 times a second the current density could be increased 10 times over the c. d. permissible in a stationary bath. Increasing the c. d. 20 times caused the cathodes to turn dark.

The air agitation method has also been tried, being somewhat inferior to the propeller method.

All methods involving motion of the bath necessitate some kind of filtering as all kinds of particles in the bath are deposited at the cathodes contaminating the silver.

We are at present working on a system connecting the fixing tanks with an electrolytic cell through 2 sets of tubes, and a pump causing the fixing solution to circulate slowly and continuously through all the fixing tanks and through the cell. Using a current of about 2 amperes and a cathode surface of 20—40 sq.dm., the silver content should be kept at the wanted level, the fixing solution may be used longer and the motion in the fixing bath will accelerate fixing.

Reaping the silver.

The silver deposit is easiest taken off the cathodes when it has attained a certain thickness. Using a current density of about 10 m.A. per sq.dm. as in stationary solutions, the unit should be in activity for at least 2 months before reaping of the silver is attempted. The cathode assembly is rinsed and dried. Then the cathode plates are taken from their ribs. The silver deposit comes off as brittle flakes when the plates are bent up and down a little.

Addendum

During the last months, carbon anodes in connection with external current sources (transformer — rectifier units) have replaced the zinc anodes in all our electrolytical units. The initial cost of such a system is higher, but it needs less attention and care than a zinc anode unit. In a stationary bath one carbon stick is used for the anode, and it is used without an anode bag. The anode should however be cleaned with a brush under the tap at a few days' interval.

SUMMARY

By electrolytic silver recovery from fixing baths in use silver is recovered as pure silver, at the same time the fixing bath is rejuvenated.

The author uses stationary baths, great cathode surface and a current density of 10 m.A. per sq.dm.

3 electrolytical units are described.

ZUSAMMENFASSUNG

Durch Elektrolyse wird aus dem Fixierbad reines, metallisches Silber wiedergewonnen, und zugleich wird das Fixierbad regeneriert.

Der Verfasser gebraucht eine ruhige Flüssigkeit, eine grosse Katodenoberfläche und eine Stromstärke von 10 m.A. pro dm.^{2}.

Drei Elektrolyseapparate verschiedener Grösse und Konstruktion sind im Aufsatz beschrieben.

RÉSUMÉ

La méthode de l'électrolyse permet de récupérer l'argent de la solution fixatrice pendant son usage, sous forme d'argent metallique pur. En même temps la solution fixatrice est renouvelée.

On doit employer une solution stagnante, en utilisant une cathode à grande surface et un courant de 10 m.A. per dm^2.

Trois appareils électrolytiques sont décrits.

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FROM THE DEPARTMENT OF DIAGNOSTIC RADIOLOGY (CHIEF: PROFESSOR ÅKE ÅKERLUND), KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN

ABERRANT PANCREAS[1]

by

Lennart Kjellman

The existence of aberrant pancreas anlages (accessory pancreas or pancreatic heterotopia) has been known for nearly a century. These rudiments are not a common finding, admittedly, but on the other hand they do not belong among the extreme rarities either; about 500 cases in all have been reported in the literature. In view of what is known respecting the pathology and clinical features of aberrant pancreatic tissue, it can no longer continue to be regarded as a mere extra finding at operation or autopsy, but must now be given a place in the field of differential diagnostics, and possesses interest not least from the aspect of roentgenology.

As the name itself indicates, pancreatic heterotopia is a malformation. At the embryonic stage there are, in point of fact, three pancreas anlages, one of which gradually disappears, in the normal fetus, while the other two develop into the true pancreas. If the aforementioned atrophy fails to take place the conditions have been created for the development of pancreatic tissue outside the main organ. Statements as to the incidence of such findings show much variation, figures of between 0.6 and 5.6 per cent being mentioned with respect to autopsy material, and a frequency of 1 case in about 500 operations on the upper part of the abdomen, in surgical statistics (BARBOSA and co-workers). In the vast majority of the cases, or in more than 70 per cent, the aberrant pancreatic tissue is, in point of fact, encountered in the first segment of the digestive canal, a finding that is only natural, because of the proximity of the pancreas bed; the tissue occurs in the stomach in roughly 25—30 per cent of the cases, and in the duodenum and jejunum in about 30 and 20 per cent, respectively. More uncommon sites are the ileum, colon, omentum, bile

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passages, spleen, et cetera. There seems to be considerable divergence of opinion with regard to the distribution over the sexes. According to FELDMAN, the proportion is 1 : 1 between men and women, while BARBOSA and his co-workers mention the figure 3 : 1, and STOHR and KÖGLER consider that the anomaly occurs much more frequently in the male sex.

The aberrant pancreas anlage appears either as an isolated, solid, rounded, slightly flattened tumour, this apparently being the commonest form, or as a cyst; in both cases, multiple formations can occur. The tissue is usually situated below the mucous membrane, and occasionally in the other layers of the walls of the stomach and intestine. The size is, as a rule, about 1—4 cm in diameter, with variations both in an upward and downward direction.

In the majority of cases, the histological structure does not appear to differ from that of normal pancreatic tissue, with its acini, lobules, ducts and Langerhans's islets, although a more uniform occurrence of certain tissues has been described. The aforementioned duct system sometimes opens, through outlet-channels, into the lumen of the alimentary canal, an occurrence which, according to BARBOSA and his co-workers, is only possible as the result of an indirect communication, through the outlet-channels opening into the gland ducts of the mucous membrane. If any of these outlet passages become closed up we have the explanation of the occurrence of the previously mentioned cyst formation.

Aberrant pancreatic tissue not only may, itself, be the seat of pathological changes but may also give rise to such lesions in adjoining tissues, and in addition may cause other disease states. In the first-mentioned case, the lesions differ in no way from those arising in the pancreas, namely, inflammation, haemorrhage, necrosis, benign tumours, or malignant degeneration. Disturbances in adjoining tissues may be in the form of fatty necrosis, haemorrhage or ulceration, and in all probability are partly to be ascribed to chemical irritation and the action of pancreatic juice; possibly, however, as BRANCH and GROSS have suggested, they may also be due to disturbance of the blood supply to the overlying mucous membrane. An aberrant pancreas anlage can furthermore contribute towards producing diverticula, but above all it can cause obstruction, especially in the region of the pylorus, and intussusception. Finally, it should be mentioned that cases have been reported where the course was marked by hyperinsulinism and hypoglycaemia, and in consequence of this it has been suggested that, in connection with an operation for suspected insulinoma, a negative finding from the pancreas should motivate a careful search for aberrant pancreatic tissue.

In the majority of the cases, the deformity gives no sign of its presence and is only discovered incidentally in connection with an operation or perhaps only at autopsy. In those cases where symptoms are complained

of, it is a strange fact that they only occur in persons between the ages of 40 and 60 years, despite the fact that the anlage has been present from birth. In view of all the above-mentioned circumstances, one cannot expect to find pronounced, unequivocal signs and symptoms of aberrant pancreatic tissue; there are, instead, a large variety, depending on the site of the deformity and to some extent also on its nature. But since the stomach and the upper segment of the small intestine constitute the sites of praedilection it is not surprising that symptoms from these organs dominate the clinical picture and resemble those observed, for instance, in gastric ulcer, duodenal ulcer, and pyloric stenosis, or else consist merely in diffuse epigastric pain. STOHR and KÖGLER mention, in particular, intense pain combined with otherwise negative findings as being a fairly characteristic clinical picture. According to both these authors and several others also, the pains are attributable to contracture in the muscle walls surrounding the pancreas anlage, this, in its turn, being due to purely mechanical irritation of the smooth muscles caused by an increased flow of blood, increase in volume, and glandular secretion in the aberrant pancreatic tissue when the acid contents of the stomach pass out into the duodenum. On the other hand, some authors, such as FAUST and MUDGETT, and others, do not consider that they could demonstrate, in their material, any connection between the subjective symptoms and the occurrence of an aberrant pancreas anlage. If the anomaly is located in the stomach, it would seem logical, in view of the lack of adequate clinical signs and symptoms, to place some hope on changes in the acidity conditions, with the idea of there being some secretion of an alkaline pancreatic juice. BARBOSA and his co-workers, however, have carried out investigations along these lines and found nothing in their material to prove the correctness of such an assumption.

It might be said without any exaggeration that clinical methods fail to give any clue at all as to the existence of an aberrant pancreas anlage. Of all the available methods of examination, roentgenography is without doubt the one that has the greatest prospect of disclosing the presence of such a deformity and of throwing light on its nature — if it is situated in the stomach or duodenum, that is to say, for otherwise it cannot be detected. A sure diagnosis can naturally only be obtained by a microscopical analysis.

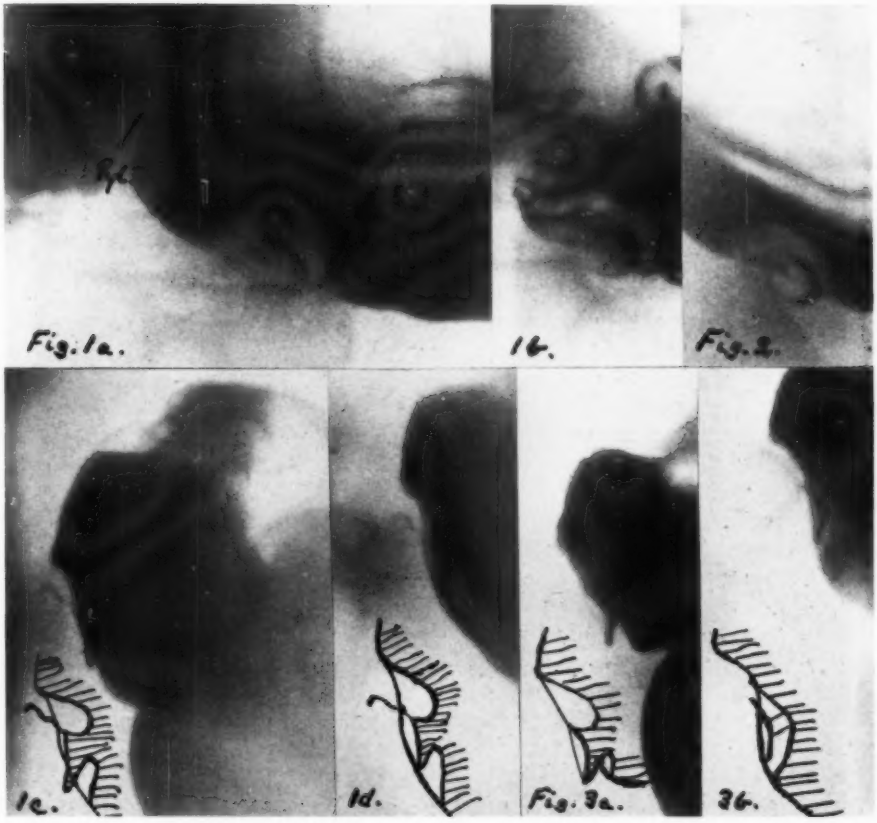
When the stomach is examined with the aid of a contrast medium, aberrant pancreatic tissue produces a broad-based, tumour-like, or in some cases a more polyp-like defect, usually round or oval in shape, and clearly defined against the surrounding tissue. The folds of mucous membrane can either run across the area or appear somewhat broken up, but in the surrounding area the mucosa is quite normal. Sometimes there is in the above-mentioned defect a hollow filled with contrast

medium; this has been thought to correspond to the outlet of a duct, but there are no reports on any filling of a duct system, despite the fact that a dilated duct system has really existed in a large number of cases. If the wall of the stomach outside the defect (in the contrast medium) is absolutely elastic, and if, in addition, the peristaltic movements continue in a forward direction without being obstructed by the tumour, these findings point strongly to the likelihood that the condition is benign, and if, also, the anomaly is situated in the region of the pylorus, where an aberrant pancreas anlage is usually located, there is reason to suspect that this type of deformity is present. But it is by no means always as easy to reach a decision regarding the roentgen picture as has been indicated here, and it is even more difficult to diagnose, or even to gain any general idea of, a similar lesion in the duodenum. It is of interest in this connection to mention a few figures from the review worked up by BARBOSA and his co-workers to demonstrate the reliability of the roentgenographic examination in the study of aberrant pancreatic tissue. When the anlage was located in the stomach the diagnosis was a benign tumour in 50 per cent of the cases, gastric ulcer in 20 per cent, and a malignant tumour in 20 per cent. The remaining 10 per cent were overlooked. When the anomaly was located in the duodenum the diagnosis was tumour in only 1 case and a duodenal ulcer in all the other cases, although an ulcer was really present in only one of them. It seems, also, to be the general belief that the roentgenologist cannot do more than diagnose a benign tumour, even though, in some cases, the true nature of the anomaly may be suspected.

As regards treatment, the majority of authors are agreed that the malformation should be removed surgically, because of the risk of complications in the future, the fear of malignant degeneration apparently being the chief motive. There is, however, no proof that such a risk exists with respect to an aberrant pancreas anlage as compared to the actual pancreas, and the uncertainty felt on this point may best be illustrated by citing the following statement from the excellent paper published by BARBOSA and his co-workers: »We feel that malignant change is more likely to take place in heterotopic pancreatic tissue than in the normally placed pancreas.»

During the past year, 3 cases possessing a certain amount of interest in the present connection have been observed at Karolinska Sjukhuset.

Case 1. (Figs. 1—3.) The first case was that of a man aged 31, who had been suffering for a short period from moderately severe pains in the epigastrium, chiefly of the hunger type and varying in position. Examination showed a slack, pillow-like inward bulge in the outline of the mucous membrane, over an area having a diameter of $1^1/_2$ cm, and situated in the distal part of the canal, on the greater curvature and close to the anterior wall. It was distinctly defined against the surrounding mucous membrane, the latter



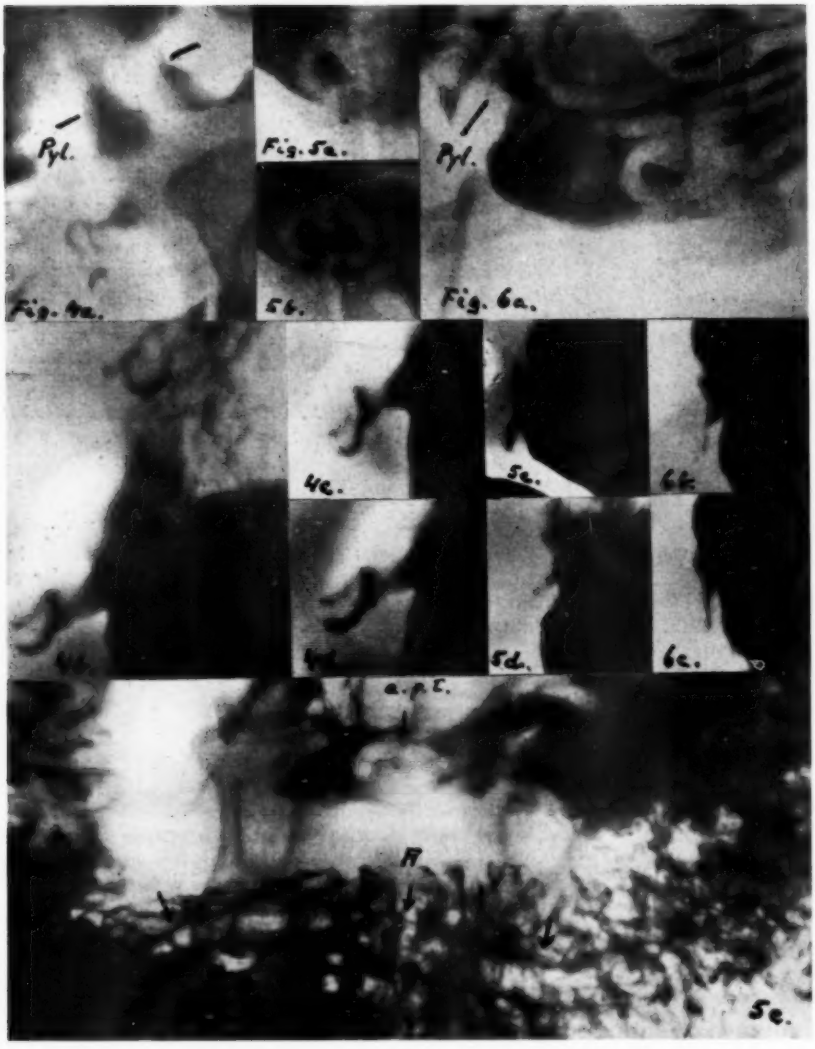
Case 1.

Fig. 1 a—d. Frontal views (a—b) at the first examination showing a spherical defect and irregularity of the contrast in the central part. Tangential pictures (c—d) at the same occasion with a cavity and a thin duct going out from the bottom of it.

Fig. 2. Roentgenogram one month later showing the constancy of the defect.

Fig. 3 a—b. Reexamination after more than half a year demonstrating the contractibility of the cavity.

having a normal outline. The peristaltic waves passed without a break over the anomaly, which was movable and contained at its centre a crater, which widened out at the bottom both in an upward and a downward direction, and probably also sideways, and varied in width. In one or two of the views an outline that appeared to be a narrow passage, originating at the distal margin, was distinguishable. In all other respects the picture of the

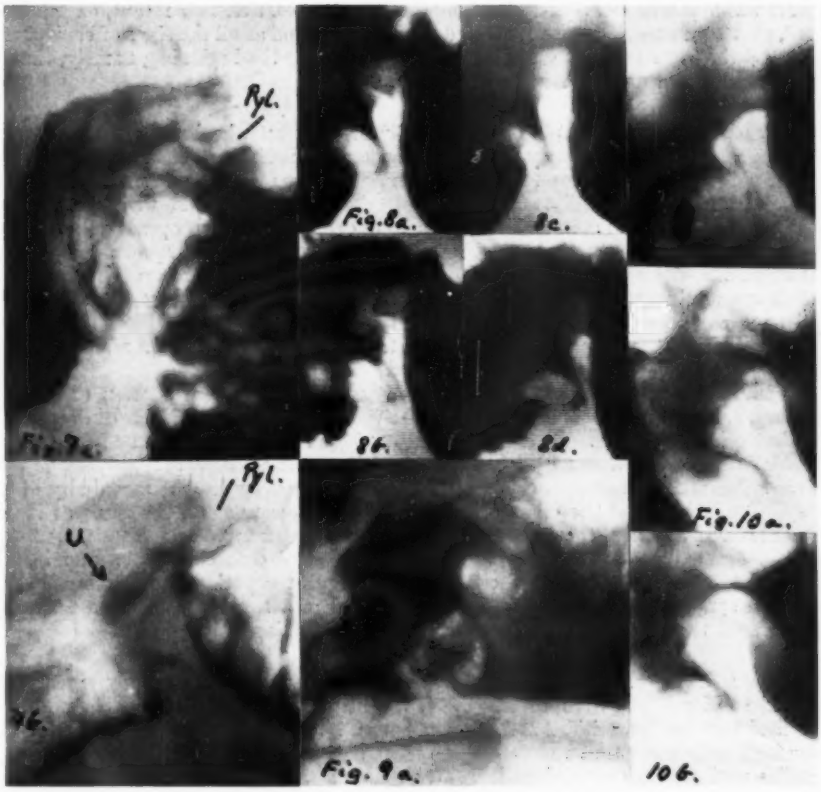


Case 2.

Fig. 4 a—d. The first examination showed ducts irregularly filled with contrast medium.

Fig. 5 a—e. Control ten days later. Radiograms in frontal position (a—b) showing the constant filling-defect. The irregularity of the ducts is visible both on the frontal and the tangential pictures (c—d). In 5 e an Ascaris (A) in the duodenum. A. p. t. = the aberrant pancreatic tissue.

Fig. 6 a—c. Four months later. Status quo.



Case 3.

Fig. 7 a—b. Radiograms in 1944 showing the deformed lateral recess of the bulb with a duct partly filled with contrast medium. U marks an ulcer.

Fig. 8 a—d. Serial roentgenograms in 1948 demonstrating the impression in the canalis ventriculi and the alteration in the filling of the ducts.

Fig. 9 a—b. Reexamination in 1949 showing the same picture.

Fig. 10 a—b. Control 3 weeks later. Status quo.

stomach and duodenum was normal. From what could be judged, the formation was benign.

At a control examination one month later, after a diet regimen, the patient had less severe symptoms, but the roentgenogram was entirely unchanged.

Another control examination 6 months later showed the same conditions. The patient was now practically free from discomfort. At this examination also, as in the earlier screenings, it was found that there was a contracting capacity in the space, indicating

that it was a question of a passage equipped with wall muscles. This meant, on the other hand, that the formation was pre-formed. This fact, as well as all the signs of benignancy, increased the suspicion that we had already formed from the beginning, namely, that an aberrant pancreas anlage was present in this patient.

Case 2. (Figs. 4—6.) This was a 24-year-old man who had been experiencing for the past month increasingly severe epigastric pain, radiating out into the back, and hunger pains. At examination the mucous membrane was seen to stand out with unusual clearness, and an intermediate layer one finger's breadth in height was distinguished. At the end of the canal a crater more than 1 cm deep and with an opening about 1 mm wide was seen on the anterior wall. The roentgenogram was misinterpreted at this examination, the diagnosis made being penetrating ulcer, with the reservation, however, that it appeared more like a fistula formation. The duodenal bulb was normal. When the patient was admitted to the hospital 10 days later it was observed in connection with another study of the roentgen pictures that the supposed ulcer was, in reality, divided and gave the impression of being a gland duct.

Another examination showed more clearly that it was not a question of an ulcer but that, as in the preceding case, there was an inward bulge in the outline of the mucous membrane in the canal, measuring about $1^1/_2 \times 1^1/_2$ cm and with a crater in the centre enclosing, as it were, a small papilla-like formation from which a narrow passage took its rise. The mucous membrane folds, the peristaltic movements, the movability of the morbid formation, and the contractibility of the passage were all the same as in the former case. In addition, there was an eelworm in the duodenum. The patient was treated for the worm and the abdominal discomfort diminished. A control roentgen examination 4 months later showed unchanged conditions, although the patient still continued to be free from symptoms. Thus, all the findings pointed to a benign, pre-formed formation and aroused the suspicion that an aberrant pancreas anlage was present.

Case 3. (Figs. 7—10.) This was a 49-year-old man who had been roentgenographed at Karolinska Sjukhuset in 1944, the diagnosis being duodenal ulcer, with a deformed bulb and gastritis. Another examination 1 month afterwards revealed that the ulcer had healed but that the defective bulb still persisted.

The patient was operated on in 1947, at Karolinska Sjukhuset, for duodenal ulcer, a bilateral vagus resection being performed. Before this, he had been roentgenographed at another hospital. An examination 8 days after the operation revealed the same defect in the bulb. In 1948, the roentgenogram was the same as before and the patient had no symptoms.

He was examined again in 1949, because of pains, not connected with his meals. The roentgen picture was the same as before. However, a rounded formation, about as large as a cherry, was then detected in the lateral part of the pyloric ring. This formation was deforming the lateral recess of the duodenal bulb and was also causing a slight impression in the pyloric part of the stomach. Immediately distal to the pylorus a narrow passage ran into the abnormality in question and soon divided into two passages; these widened out slightly towards the end, and somewhat resembled gland ducts. The entire length of the system of passages was about 1 cm. A control roentgenogram taken 3 weeks later, after a diet regimen, was the same as before. The patient was considerably improved subjectively, however.

Renewed study of the earlier roentgenograms revealed that the deformity had been present in these also, but had obviously been overlooked. The passages also were distinguishable in the older films, the lumen varying in width in serial views depending on various states of contraction; this fact was also established during screening. As the

changes had remained unaltered for more than five years there would seem to be little doubt as to their benignancy. The passages equipped with wall muscles indicated that it was a question of a pre-formed formation, this leading us to suspect the presence of an aberrant pancreas anlage.

In the above-mentioned cases there were thus entirely similar changes, in the form of both rounded, slack, inward bulges in the outline of the mucous membrane, about $1^1/_2 \times 1^1/_2$ cm in size, causing rarefaction of the contrast medium, and crater-like hollows in the centre of them filled with contrast medium, and sending out from the bottom apparently fine passages showing a club-like swelling on the peripheral aspect. At repeated examinations during an observation period of $6^1/_2$ months, 4 months and $5^1/_4$ years, respectively, in the three cases, these rarefactions in the contrast medium remained unchanged in shape and size. They were, furthermore, sharply defined against the background, and the mucous membrane folds, which were otherwise normal, were only slightly distorted just at the site of these formations. The formations caused no break in the peristaltic waves, however. In the first two cases it was also observed that the stomach wall in the vicinity of the anomaly had retained its movability. This feature was not so marked in the third case owing to the position of the deformity in the firm pyloric ring, which does not allow the same degree of elasticity.

The above-mentioned characteristics tally, also, with all desirable clarity, with the features considered to be typical of benign tumours.

Furthermore, the features noted in the roentgen pictures, namely, the variations in width and contrast filling in the central spaces, as well as the contractile capacity of the spaces as revealed by screening, are only to be explained by assuming the existence of passages provided with their own wall muscles and closely resembling those occurring in a gland. This, in its turn, means that the changes must have been pre-formed.

The conclusion reached on the basis of the above-mentioned reasoning was that an aberrant pancreas anlage was present in these patients. Unfortunately, the diagnosis has not been verified by histologic examination, as the physicians who remitted the cases for diagnosis have obviously not considered an operation necessary. In all probability, also, there was no connection between the roentgenological findings and the patients' symptoms in cases 1 and 2. In case 3, the ulcer niche observed earlier may well have been due to the adjoining aberrant pancreatic tissue.

Since this paper went to press another case of aberrant pancreatic tissue situated in the bulbus duodeni has been operated on at Karolinska sjukhuset. The diagnosis is verified microscopically. The roentgen picture corresponds well with that of the above-mentioned cases and thus supports the stated observations. The case will be published in detail later.

SUMMARY

A report is made on three unconfirmed cases of aberrant pancreas anlage, two located in the stomach and one in the duodenal bulb. The roentgen features motivating the diagnosis are described.

ZUSAMMENFASSUNG

Verf. berichtet über drei Fälle von aberrierenden Pankreasgängen. In zwei von diesen waren sie, den Röntgenbildern nach zu schliessen, im Magen lokalisiert, und in einem im Bulbus duodeni. Die Röntgenbefunde auf Grund welcher die Diagnose gestellt wurde, werden beschrieben. Die autoptische Sicherstellung der Diagnose war nicht möglich.

RÉSUMÉ

Relation de trois cas de pancréas aberrant — sans confirmation directe — dont deux étaient localisés à l'estomac et l'un au bulbe duodénal. Description des caractéristiques radiologiques justifiant le diagnostic.

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HAEMANGIOMA OF VERTEBRA ASSOCIATED WITH COMPRESSION OF THE SPINAL CORD[1]

by

Olaf Brøbeck

In 1912 FIBIGER reported a case of vertebral haemangioma found post mortem. Up to then, only five cases had been reported in the literature.

In large autopsy materials it has been found by MAKRYCOSTAS (1927), continuing SCHMORL's studies, by TOEPFER (1928), and by JUNGHANNS (1932) that vertebral haemangiomas were present in about 10 per cent. of individuals autopsied. The majority, however, were small (not larger than a hazel nut), clinically silent haemangiomas. In only one case had the lesion encroached upon the upper surface of the vertebra, resulting in herniation of the nucleus pulposus into the defect. Usually, the haemangiomas were solitary, occurring with female predominance and increasing in incidence with advancing years. The site of predilection was the dorsal column, the lumbar column being more rarely involved. Vertebral angiomas have often been found to co-exist with angiomas of other bones, of the liver, or of the skin (KARSHNER et al.).

Haemangioma of bone, which made up less than 1 per cent. of bone tumours in CHRISTENSEN's analysis of 1,000 cases, is most frequently localized in the spine (COLEY, BRAILSFORD).

The haemangiomas, which usually range in size from that of a pea to that of a walnut, are of a dark red colour, sharply defined, and made up of cavities lined with endothelial cells. They are benign, infiltrative growths, metastatic activity being unknown. Nevertheless, they possess a certain growth energy, particularly apparent in the young age groups where most of the symptomatic cases occur. At a more advanced age, the growth energy appears to be slight, and stationary haemangiomas (or

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telangiectatic formations /PUTSCHAR/) may be encountered, probably as a link in senile osteoporosis. The haemangiomas displace the normal bone marrow which is partially transformed into fatty tissue. The bony trabeculae of the spongiosa are eroded, particularly the horizontal ones. The vertical trabeculae are reduced in number, but thicken (»compensatory hypertrophy», HORMANN). This lends the vertebra the characteristic net-like appearance. Further growth may result in an increase in the volume of the vertebra, its contours changing from concave to straight or even convex. The angioma may occupy a varying part of the body, extending also into the transverse process, the arch, and spinous process. If the angioma remains within the body without altering the shape of the latter, it will probably remain clinically silent. Pressure upon the cord may result from bulging of the posterior border of the vertebra as a result of rupture into the epidural space or collapse of the vertebra and posterior displacement of its posterior part. The spinal nerves may become involved too, when the angioma extends to the arch, thus narrowing the intervertebral spaces. The angioma may spread to the paravertebral soft parts, giving a roentgen appearance which may be mistaken for a cold abscess (shown post mortem to be due to propagation of the angioma in SCHEID and BUCKHARDT's case). IACOBOVICI has reported a case in which the angioma spread to the soft parts of the back in the form of a prominent, pulsating growth.

These are the pathological changes underlying the characteristic *roentgen picture* which is practically pathognomonic of the disease. As a rule, small silent angiomas are not visualized on the roentgen film, but larger growths — occupying a minimum of one-fourth of the body of a vertebra (cf. CHASIN's investigations) — lend the vertebra a peculiar, coarse, net-like structure. The horizontal trabeculae are greatly reduced in number, the vertical ones also, but they are broader, extending through the entire vertebral body. If the angioma spreads further, increasing the volume of the vertebra, the contours become straight or convex. In such cases backward bulging of the posterior aspect of the vertebra is of diagnostic significance. Moreover, the haemangioma may be seen to spread into the arch and the transverse processes which increase in volume and show a spongy pattern. Sometimes a spindle-shaped paravertebral shadow may suggest a cold abscess. The intervertebral space is intact.

This is the most common roentgen appearance. At times, however, the pattern may be more vesicular (ALPERS and PANCOAST, HOLTAS) or there may be increased density (ZDANSKY), giving rise to differential diagnostic difficulties. In the most common and »classic» cases, there should be no difficulty in differentiating the condition from the lesions which most frequently give rise to doubt, *i. e.* Pott's disease, metastases

from malignant tumours, giant cell tumour, Recklinghausen's disease, Hodgkin's disease, and myelomatosis. The differential diagnostic possibilities have been discussed in detail by MOSSESIAN.

The roentgenologic characteristics were first described by PERMAN (1926) who was able to classify a case previously reported by GOLD within this group. In 1929, BAILEY and BUCY described the characteristic roentgen findings.

From a clinical and roentgenological point of view, angiomas of the vertebrae are divisible into 4 groups (FOSTER and HUEBLEIN).

1) *Asymptomatic vertebral haemangioma*, discovered incidentally in the course of roentgen examination of the chest, genito-urinary tract, gastro-intestinal tract, etc. These are unaccompanied by subjective symptoms or neurological changes. In young subjects, where one film can give no idea of the growth energy of the haemangioma, periodic observation is justified.

2) *Symptomatic vertebral haemangioma* with localized spinal and/or radicular pain, without objective signs of damage to the cord or nerve roots, usually associated with back pain. Several cases of this variety have been successfully treated with roentgen therapy (*inter alia* IRELAND, LIÈVRE, SCHEEL).

3) *Vertebral haemangioma accompanied by subjective and objective signs of compression of the spinal cord due to expansion into the epidural space.* These patients require treatment, which presumably should consist in a combination of laminectomy and radiotherapy.

4) *Vertebral haemangioma which has undergone pathological fracture* altering the shape of the vertebra, perhaps accompanied by cord compression.

Most interest attaches to the third group which is being diagnosed in increasing numbers by roentgen examination — the only method of making the diagnosis prior to operation. Wrong diagnoses are, however, still being made because of lacking familiarity with the characteristic roentgen appearance.

In 1939 SCHEEL collected 31 cases of vertebral haemangioma associated with cord compression from the literature. The writer has succeeded in finding reports of 26 additional cases, bringing the total up to 57 plus the one to be reported below.

The age incidence ranges from puberty (the youngest patient /KAPLAN's/ being $12^1/_2$ years of age) to fairly advanced age (the oldest patient, reported by ZDANSKY, was 64), and there is a slight female predominance. The great majority of the growths had their site in the dorsal column (mostly in its middle or inferior parts), a few, however, involving the lumbar column and still fewer the cervical column.

Case Report

Department of Neurosurgery, Aarhus Municipal Hospital, Case rec. 4789

Machinist's apprentice, aged 16, admitted on March 31, 1948.

Abstract from case record:

For 8 months gradually increasing disturbances of gait, rapidly progressing during the past 2 months. For 5 weeks complete paralysis of both lower limbs. For one month increasing paraesthesiae in both legs and gradually diminishing sensibility as far as the 7th—8th thoracic segments. No sphincter disturbances.

Objective findings:

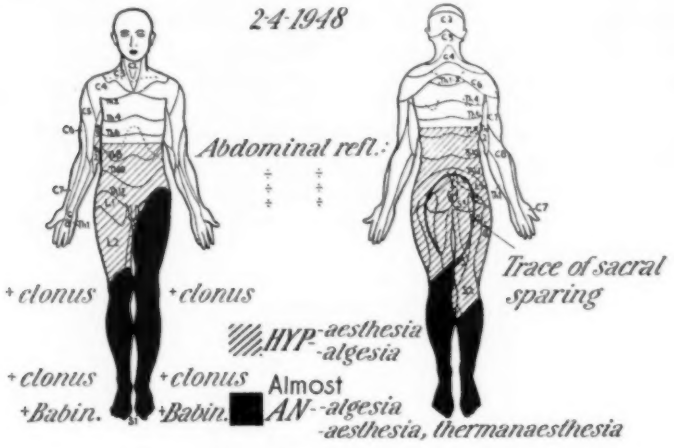

Fig. 1. *Neurological status* on admission.

Slight left-sided scoliosis affecting the dorsal column with a summit on a level with the 7th dorsal vertebra. Mild tenderness to palpation over the 6th, 7th, and 8th dorsal vertebrae. Spastic paraparesis of the lower limbs. Hypaesthesia, hypalgesia on both sides below the 7th thoracic segment with diminishing tactile sensation distal, so that there is analgesia and anaesthesia extending on the left from the 1st lumbar segment to the 2nd sacral segment and on the right from the 3rd lumbar segment. In addition, a trace of sacral sparing. The temperature sensation was changed in the same area as the tactile sensation, the deep sensibility lost in both feet, abdominal and anal reflexes absent, patellar and ankle clonus, bilateral Babinski. Lumbar puncture showed a complete block and a xanthochromic spinal fluid.

Roentgen examination of the dorsal column

Figs. 2 a, b, and 3 a, b.

No abnormal curvature. The body of the 7th dorsal vertebra is the seat of pronounced pathological changes, showing a coarse, net-like pattern with coarse, predominantly vertical trabeculae. There is distinct bulging of the anterior and lateral contours

Fig. 2 a.

Fig. 3 a.

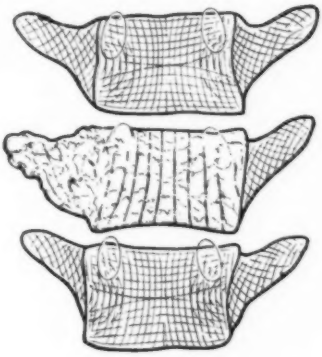

Fig. 2 b.

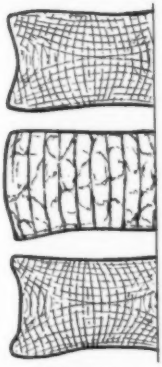

Fig. 3 b.

Antero-posterior and lateral views of the 7th dorsal vertebra, showing the typical angiomatous structure with a net-like osseous pattern, coarse, mainly vertical trabeculae, bulging of the vertebral contours. The process extends into the left transverse process and arch. No narrowing of the intervertebral spaces, no increase in the paravertebral shadow.

of the vertebra; the posterior contour is not seen distinctly. Left contour ill-defined. No narrowing of the intervertebral spaces, no increase in the paravertebral shadow. The process encroaches upon the left transverse process which is vacuolated and increased in breadth; the arch is ill-defined. *Roentgen diagnosis:* Vertebral haemangioma.

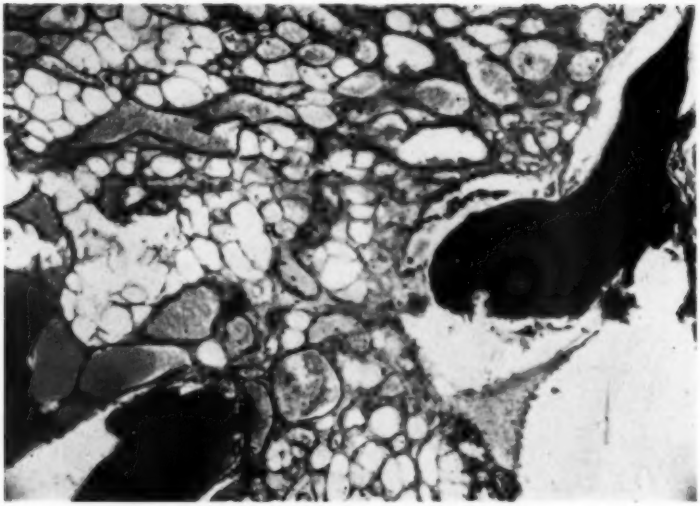

Fig. 4. *Photomicrograph of tissue removed from the arch.*
Typical angioma with sinuous vessels, lined with endothelial cells, rich in erythrocytes, with sparse intercellular substance and a few coarse bony trabeculae.

April 3, 1948: *Operation* (MALMROS).

Left-sided hemilaminectomy involving the 6th, 7th, and 8th dorsal vertebrae. Skin and soft parts normal. Severe changes of the arch of the 7th dorsal vertebra. When the muscles were detached from the arch, numerous small haemorrhages appeared on its surface. The arch was invaded by the vascular tumour tissue which had increased its volume, so that it projected into the spinal canal, compressing the cord from behind. All the bony tissue was removed on the left side, whereupon the tissue projecting into the spinal canal was removed from below the arch on the right. This caused profuse bleeding, but the resection was continued as far as the pedicle. The changes are uniform throughout. Haemostasis was obtained partly by applying bone wax, partly by applying muscle à demeure.

Histological examination of tissue specimen: (Fig. 4) Simple angioma (sd. ERNA CHRISTENSEN, LUND).

No symptoms after the operation. Postoperative course uneventful.

On April 12 *roentgen therapy* was started with 8 sittings of 150 r daily. Target-skin distance 40 cm., 1 mm. aluminium and 1 mm. Cu filtration, 4 ma., and 150 kv., a total of 1,200 r.

Thereupon, he received 100 r daily with a target-skin distance of 50 cm., through a Thoræus filter, 4 ma., and 160 kv., a total of 2,800 r.

In all, he received 4,000 r through a 10×20 cm. field on the back.

The patient made a rapid recovery, and when discharged on May 8, 1948 he was able to walk fairly well with the aid of one stick. He still showed a slight spastic paraparesis of the lower limbs and bilateral Babinski.

Re-admitted on Nov. 6, 1948.

Neurological findings: Almost normal; power and sensibility in the lower limbs normal. There is still some spasticity and a tendency to patellar and ankle clonus. Spinal fluid shows a slightly increased total protein content. *Roentgen examination of the vertebral column* showed the changes of the 7th dorsal vertebra unaltered.

Re-admitted on June 25, 1949.

The patient is now feeling well and enjoying full working capacity.

Neurological findings normal.

Roentgen examination of the vertebral column: Unchanged.

Summary of the Case

A male, aged 16, had for 8 months been developing a spastic paraparalysis of the lower limbs, hypaesthesia, hypalgesia below the 7th thoracic segment. Loss of deep sensibility in both feet.

Lumbar puncture showed a complete block and a xanthochromic spinal fluid.

Roentgen examination of the dorsal column showed the changes characteristic of haemangioma in the body of the 7th dorsal vertebra.

The patient was submitted to hemilaminectomy involving the 6th, 7th, and 8th dorsal vertebrae. This revealed an extradural vascular tumour which had increased the volume of the arch of the 7th dorsal vertebra, lending it a vacuolized pattern. All the intraspinal tumour tissue was removed.

Histological diagnosis: Simple angioma.

Postoperative roentgen therapy was given.

The patient made a rapid recovery, was relieved of subjective symptoms and regained his full working capacity in the course of about 6 months. Normal neurological findings upon follow-up admission 19 months after the first admission.

Comments

This patient's history is characteristic of the disease: The usually prolonged, insidious development of disturbances of gait, progressing to paraparesis and increasing disturbances of sensibility. As emphasized as early as 1926 by PERMAN, pain is a rare and often late symptom. The pain may sometimes occur in periodical attacks, presumably brought on by fluctuations in the congestion in the cavernous blood spaces of the haemangioma (HORMANN, ALPERS and PANCOAST). The symptoms have been reported to become intensified during the menstrual periods (IACOBOVICI) and during pregnancy (MICHON et al.).

It has been discussed, whether the structural changes caused by the angioma in the vertebra entailed increased fragility of the bone. While injury must be considered of no etiological significance, collapse of angiomatous vertebrae has been reported in but few cases

(MUTHMANN, SANDAHL, HOLTA). When pathological fracture occurs, the vertebrae may become biconcave (JUNGHANNS) and the characteristic angiomatous structure may become more or less obliterated by the increased density of the bone (RUPPERT, ZDANSKY). Fracture of the vertebral column has been reported in several cases in which an angiomatous vertebra failed to exhibit any signs of fracture, whereas the neighbouring vertebrae had been fractured by severe injury (SANDAHL, STEHR, GRIEP).

Some disagreement has prevailed as to the correct form of *treatment*. Surgical measures (perhaps followed by roentgen therapy) are recommended by some workers (*inter alia* BUCY and CAPP, KARSHNER et al.), whereas others have obtained good results by roentgen therapy alone (*inter alia* NATRASS and RAMAGE, MICHON et al., GREGOIRE and LAFONT, FERBER and LAMPE, FOSTER and HUEBLEIN). Roentgen irradiation is often followed by signs of improvement in 1—3 weeks, a period so short that it cannot be presumed to play any rôle in aggravating a slowly developing myelopathy. In the early years, several patients were reported to have succumbed to profuse bleeding in the course of operation, but this tragic outcome is seldom reported in recent publications and must be expected to become even more uncommon in the future due to an increased knowledge of the syndrome, particularly the characteristic roentgen appearance, and to improved operative technique.

SUMMARY

A vertebral haemangioma in a male, aged 16, is reported. The haemangioma, which involved the 7th dorsal vertebra, pressed upon the spinal cord, causing spastic paraparesis of the lower limbs. The characteristic roentgen findings are described.

Complete recovery followed upon a combination of surgery and radiotherapy.

ZUSAMMENFASSUNG

Es wird über ein Wirbelhämangiom bei einem 16jährigen Knaben berichtet. Das den 7. Brustwirbel angreifende Hämangiom drückte auf das Rückenmark und erzeugte eine spastische Parese der unteren Extremitäten. Die charakteristischen Röntgenbefunde werden beschrieben.

Nach kombinierter chirurgischer und röntgenologischer Behandlung trat völlige Heilung ein.

RÉSUMÉ

Relation d'un cas d'hémangiome vertébral chez un homme de 16 ans. L'hémangiome, qui envahissait la 7e vertèbre dorsale, comprimait la moelle épinière et causait une paraparèse des membres inférieurs. Description des images caractéristiques trouvées aux Rayons Roentgen.

Une guérison complète succéda au traitement combiné par la chirurgie et la radiothérapie.

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FROM THE ROENTGEN-DIAGNOSTIC DEPARTMENT (CHIEF: PROFESSOR OLLE OLSSON)
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HYSTEROGRAPHY IN CANCER OF THE CORPUS OF THE UTERUS

Suppl. LXXIX, Acta Radiologica, 156 pages, 57 illustrations.
Autoreview

by

Olof Norman

Hitherto our knowledge of the characteristics of the roentgen picture of cancer of the corpus of the uterus and of the possibilities of diagnosing this disease hysterographically have been deduced from a few relatively limited series. In these series iodized oil was used as a contrast medium.

That this examination method did not find wider use is due to the opinion generally expressed in the literature that it is dangerous to submit patients with cancer of the corpus to hysterography on account of the risk of spread of infectious or cancerous matter.

During slightly more than three years (20. 11. 46—30. 12. 49) 128 patients from the Radiological and Gynecological Clinics, Lund, with clinically suspected or microscopically verified cancer of the corpus of the uterus were submitted to hysterography by the author at the Roentgendiagnostic Department of the University Clinics, Lund. During the period 27 patients were regarded for some reason or other as being less suitable for hysterography.

The technique employed is described. Umbradil (supplied by A. B. Astra), a water soluble contrast medium of the diodrast type was used. As a rule the examination gave the patient but slight discomfort. In the beginning of the investigation the patients received penicillin intrauterinely in combination with the hysterographic examination.

The study showed the roentgenographic appearance of cancer of the corpus to be manifold but that all its variants presented characteristic traits. As the roengenological variants could be grouped only schematically, the author preferred to give ample illustrations.

From the series two groups were selected according to their roentgenographic appearances, one comprising large, smooth-outlined tumours,

the other, comprising tumours with a very irregular outline. These two groups were compared with histological specimens and found to represent very different degrees of organization and differentiation. It was thus possible in the major part of the series to bring the different roentgenographic appearances into definite correlation with histological types of cancer.

The possibilities of making a differential diagnosis and the degree of certainty attainable by means of hysterography are discussed. With reference to this discussion hysterography is claimed to be an examination method satisfying the requirements of the clinician in classifying cancer of the uterus and grouping cancer of the corpus, and the method is suggested for a more detailed differentiation. The practical value of hysterography for the diagnosis of cancer of the corpus is discussed from different angles. It is claimed that hysterography should always be resorted to in cases in which microscopy of tissue removed at curettage of a patient suspected for cancer gives a negative result.

A detailed discussion is given of the diagnostic situation of the patients referred to the Radiological Clinic. Hysterography was found essentially to complement instrumental intra-uterine exploration and to be superior to the latter for estimating the localization and extent of growth of the tumour.

The patients were controlled roentgenologically both during and after radium treatment in order to study the reaction of the tumour to the treatment. The results suggested that this procedure might become an important aid in deciding whether or not a patient should be operated on later.

In several cases roentgen control revealed endometrial changes which the author interpreted as radiation reaction.

As to risks incurred by hysterography of patients with cancer of the corpus it should be mentioned that:

Hypersensitivity to the contrast medium was observed in one case only;

Mechanical perforation sustained by various kinds of instrumental examination was no uncommon observation and sometimes occurred in connection with hysterography. In all such cases the complication ran a favourable course. In some cases the perforation had not been observed clinically before hysterography;

The risk of spread of the tumour is a theoretic possibility. The patients in the present series had been followed-up for a maximum time of $3^1/_2$ years and so far no signs of such spread have been observed;

Infectious spread as a consequence of hysterography carried out on 411 occasions on 128 patients was just as uncommon as in other mixed series of patients without manifest cancer.

SUMMARY

The author gives a short abstract of his work »Hysterography in Cancer of the Corpus of the Uterus» published as Supplementum LXXIX to Acta Radiologica.

ZUSAMMENFASSUNG

Verf. gibt eine kurze Zusammenfassung von seiner Arbeit »Hysterography in Cancer of the Corpus of the Uterus» (Hysterographie bei Ca. corporis uteri) veröffentlicht als Supplementum LXXIX der Acta Radiologica.

RÉSUMÉ

L'auteur donne une analyse abrégée de son ouvrage »Hysterography in Cancer of the Corpus of the Uterus» (L'hystérographie dans le cancer du corps de l'utérus), publié comme Supplementum LXXIX aux Acta Radiologica.